GSFC 424-12-00-01

EOS CHEMISTRY & SPECIAL FLIGHTS PROJECT

SOFTWARE MANAGEMENT PLAN

FEBRUARY 16, 1996

NASA Goddard Space Flight Center
Greenbelt, Maryland

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CHANGE RECORD

DOCUMENT TITLE:	EOS CSFP SOFTWARE MANAGEMENT PLAN	REVISION:
DOCUMENT DATE:	February 16, 1996	PAGE 1
DOCUMENT NUMBER:	424-12-00-01	

ISSUE	DATE	PAGES AFFECTED	DESCRIPTION
Original	February 16, 1996	All	Initial release Approved by CCR 424-12-20-002 The CCR formally baselines the subject document and places it under configuration control

AFFECTED PAGES

DOCUMENT TITLE:	EOS CSFP SOFTWARE MANAGEMENT PLAN	RELEASE DATE: February 16, 1996

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SECTION 1.0 - INTRODUCTION

The Earth Observing System (EOS) Chemistry & Special Flights (CSF) Project (CSFP) is a part of NASA's Mission To Planet Earth (MTPE) Program. The EOS spacecraft, designated:

- AM (morning equatorial descending crossing time)
- PM (afternoon equatorial ascending crossing time)
- ALT (Altimetry)
- CHEM (Chemistry)

will be flown as flight series, carrying payloads designed to measure various aspects of the Earth's physical phenomena from which specific data products can be derived.

Several of the EOS spacecraft will be based on a common spacecraft, namely:

- the PM flight series,
- the AM flight series (beginning with AM-2),
- the CHEM flight series.

The CSF Project is responsible for the CHEM and ALT series, and Flights of Opportunity (FOO).

CSFP Instruments that are not flown on the CHEM or ALT satellites are referred to as Flights Of Opportunity (FOO). In some cases, the spacecraft on which an instrument will be flown is not yet determined.

The instrument complement for the Project is shown in Table 1-1.

Figure 1.0-1 shows the CSFP mission profile through the year 2006.

The CSF Project is the "**acquirer**" of software capabilities and related services. This applies to any software/related-services funded by the CSFP, whether or not the software/services are delivered to CSFP. In some cases the products of CSFP-funded software development may be delivered directly to a third party end-user. These capabilities and related services may be provided by other NASA organizations, Universities, general and mission support contractors or contractors providing end-items with embedded and support software. Throughout this document the term "**Project**" is used to refer to the CSF Project in its role of software acquirer. The term "**EOS Project**" refers to GSFC's MTPE Office, Code 170.

Throughout this document the term "**provider**" is used to refer to developers and providers of software and software services, regardless of the nature of their organization or their affiliation with the Project.

SPACECRAFT		INSTRUMENT	RESPONSIBLE AGENCY
TRMM	**(1997)**	LIS	MSFC
ALT RADAR	(1999)	AMR	JPL
		DORIS	CNES
		SSALT	CNES
ACRIMSAT	(1999)	ACRIM	JPL
CHEM-1	(2002)	HIRDLS	NCAR / OXFORD UNIVERSITY/RAL
		MLS	JPL
		TES	JPL
		ODUS	NASDA
ALT LASER	(2003)	GLAS	GSFC
tbd		SOLSTICE	NCAR

Table 1-1 CSFP Instrument Complement

1.1 IDENTIFICATION OF DOCUMENT

This is the Software Management Plan (SMP) for the CSFP flights.

1.2 SCOPE OF DOCUMENT

This SMP describes the management process for EOS CSFP software development and maintenance, and describes the management of the interfaces between the organizations having software responsibility to this project. It identifies the roles that the various software development and maintenance organizations, and the EOS CSF Project staff, have in this process.

This SMP is not intended to impose management requirements on the providers. Software management requirements on the common spacecraft developers can be found in the EOS Common Spacecraft Software Management Requirements Document (SMRD) [ref. 2.4-2]. Requirements on instrument developers are contained in the CSFP Instrument Software Management Requirements Document (ISMRD) [ref. 2.4-7]. Software management requirements on science software providers are contained in the appropriate working agreements.

Except for software and hardware interfaces to Project capabilities, and schedules for the availability of support resources, it does not apply to operational institutional capabilities that are not specifically developed or modified to support the Project.

Additional information on the scope of this document can be found in Section 3.0 (Purpose and Description of Project Software), and Section 4.3.3 (Organization).

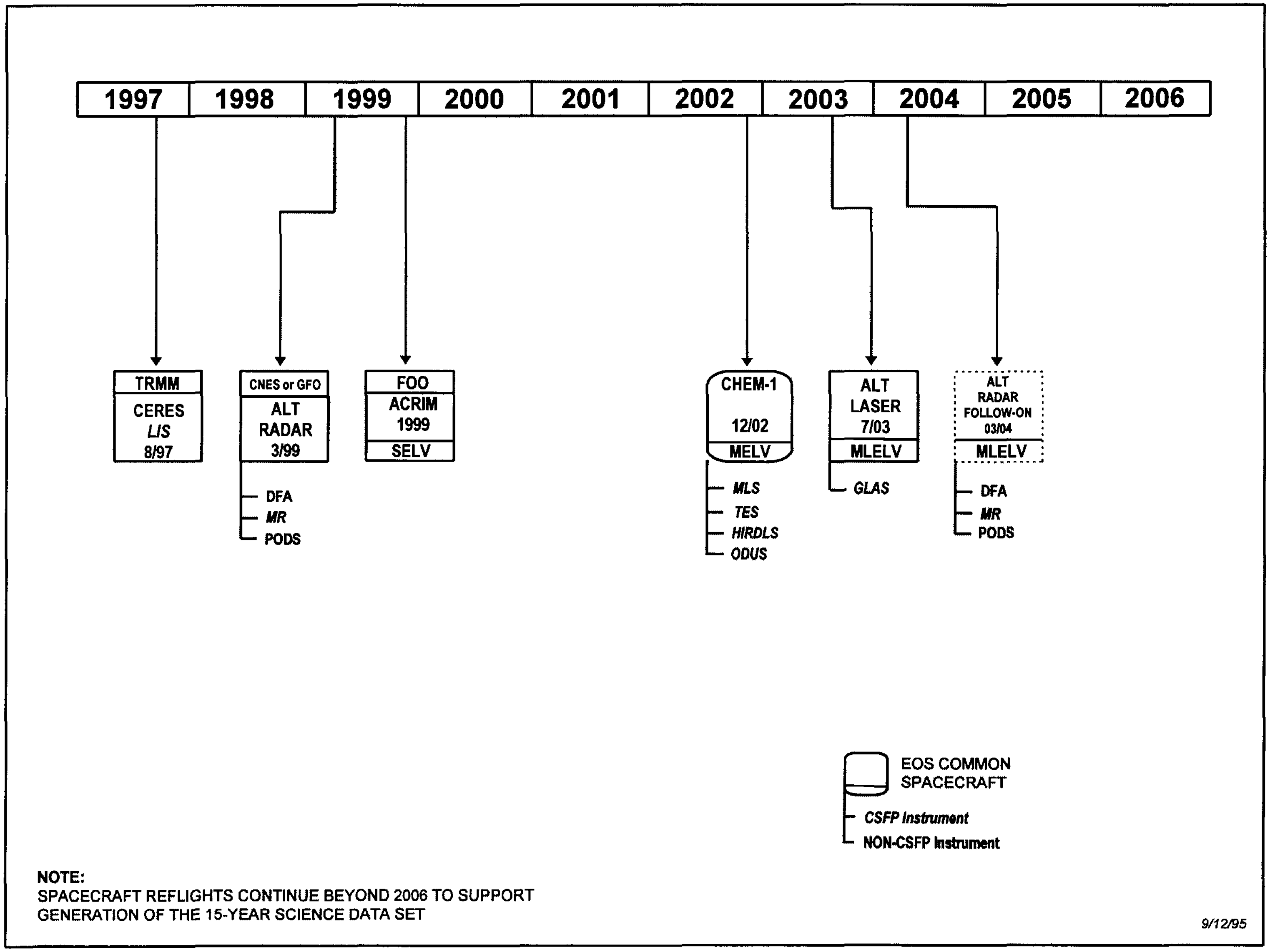

Figure 1.0-1 CSFP Mission Profile

The term "software" as used in this document includes code, documentation, associated data, and "firmware". Firmware is defined as code and data loaded into memory devices which cannot be modified on orbit.

1.3 PURPOSE AND OBJECTIVE OF DOCUMENT

The purpose of this SMP is to define software management processes to be followed by the Project, and responsibilities, standards, procedures and organizational relationships for all software activities associated with the Project's flights. It establishes software acquisition and development practices, standards, and technical procedures in compliance with GMI 2410.7 [ref. 2.2-4] and NMI 2410.10B [ref. 2.2-6].

1.4 DOCUMENT STATUS AND SCHEDULE

This is the working copy of the SMP. The final version will be peer reviewed according to GMI 2410.7 [ref. 2.2-4]. The approved version will then be placed under Project Configuration Management (CM) control. The SMP will be revisited by the Project Software Systems Manager (SSM) periodically, and updated on an as-needed basis. All changes will be reviewed and approved by the Project Configuration Control Board (CCB) before publication of an updated version of this Plan. This satisfies the document maintenance requirement of GMI 2410.7 [ref. 2.2-4].

1.5 DOCUMENT ORGANIZATION AND ROLL-OUT

The organization, format, and content of this plan follow the Management Plan Data Item Description (NASA-DID-M000) specified by NASA Software Documentation Standard (NASA-STD-2100-91).

This SMP is organized as follows:

- Section 1 - provides an overview of the context, structure, and content of this SMP.
- Section 2 - identifies documents that contain the requirements and references used in this SMP.
- Section 3 - identifies and provides a description of the software that the Project will acquire.
- Section 4 - defines the business practices to be used by the Project.
- Section 5 - defines the Project's software management practices.
- Section 6 - N/A. Development planning will be included in the provider's Software Management Plan.
- Section 7 - describes the Sustaining Engineering and Operations Activities after the software is turned over to the operations staff.
- Section 8 - defines the Project's software assurance program by defining the Project's oversight activities.

- Section 9 - identifies the Project's software risk management processes .
- Section 10 - identifies the Project's approach to software configuration management.
- Section 11 - describes the Project's processes for delivery and operational transition.
- Section 12 - defines all abbreviations and acronyms used within this document.
- Section 13 - is a glossary of all special terms used within this document.

All software management requirements on the software providers are rolled out into separate documents:

Software management requirements on the common spacecraft developers can be found in the EOS Common Spacecraft Software Management Requirements Document (SMRD) [ref. 2.4-2]. Requirements on instrument developers are contained in the CSFP Instrument Software Management Requirements Document (ISMRD) [ref. 2.4-7]. Software management requirements on science software providers are contained in the appropriate working agreements.

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SECTION 2.0 - RELATED DOCUMENTATION

The document dates listed below are the ones believed to be current at the time of publication of this document. If a referenced document is superseded by a later version, then the later version will apply.

2.1 PARENT DOCUMENTATION

This is the top-level document of the CSFP Chemistry Flight's Documentation Set.

Figure 2.1-1 shows the position of this document in the CSFP Chemistry Document Hierarchy.

Figure 2.1-2 shows the position of this document in the CSFP Laser Altimetry Document Hierarchy.

Figure 2.1-3 shows the position of this document in the CSFP Flights of Opportunity Document Hierarchy.

The CSFP Radar Altimetry Documentation Tree is TBS pending a decision on the mission implementation approach.

2.2 APPLICABLE DOCUMENTS

The policies, standards, procedures, and formats contained in the following documents, along with the contents of this SMP, form the basis of the Project's software management approach.

[2.2-1]	GSFC 170-01-01	Execution Phase Project Plan for the Earth Observing System (EOS), September, 1993.
[2.2-2]	GSFC 420-02-02	Earth Observing System Configuration Management Plan, January, 1990.
[2.2-3]	N/A	
[2.2-4]	GMI 2410.7	Software Management, Engineering, and Assurance Requirements, June 29, 1993.
[2.2-5]	NMI 2410.7C	Assuring the Security and Integrity of NASA Automated Information Resources, April 8, 1993.
[2.2-6]	NMI 2410.10B	NASA Software Management, Assurance, and Engineering Policy, April 20, 1993.
[2.2-7]	NASA-STD-2100-91	Software Documentation Standard, July, 1991.
[2.2-8]	NASA-STD-2201-93	Software Assurance Standard, November 10, 1992.
[2.2-9]	NASA-STD-2202-93	Software Formal Inspections Standard, April, 1993.
[2.2-10]		NASA Software Acquisition Life Cycle, Version 4.3
[2.2-11]	GSFC 420-02-03	EOS Project Configuration Management Procedures Handbook, Revision A, January, 1993.

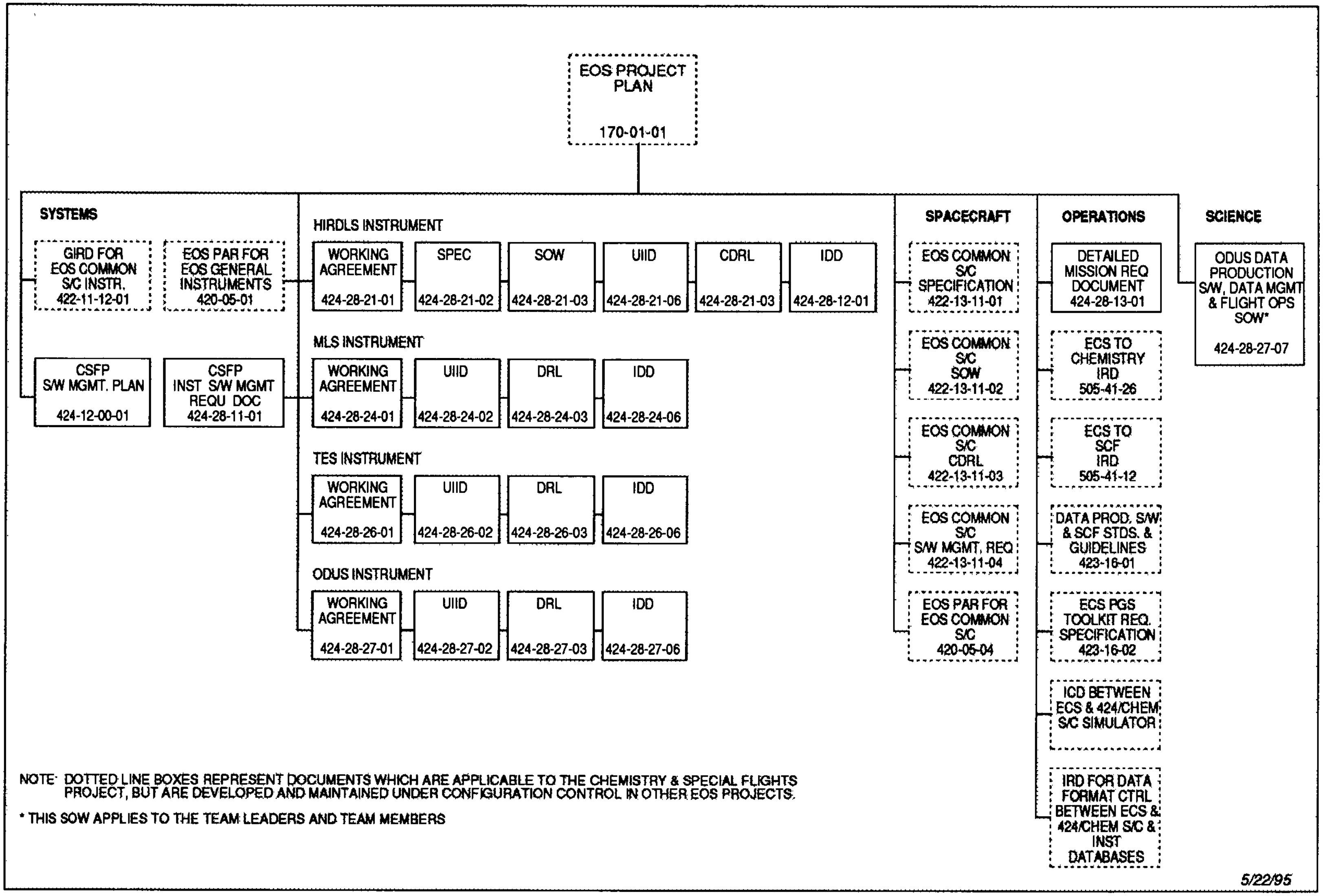

Figure 2.1-1 CSFP Chemistry Documentation Tree

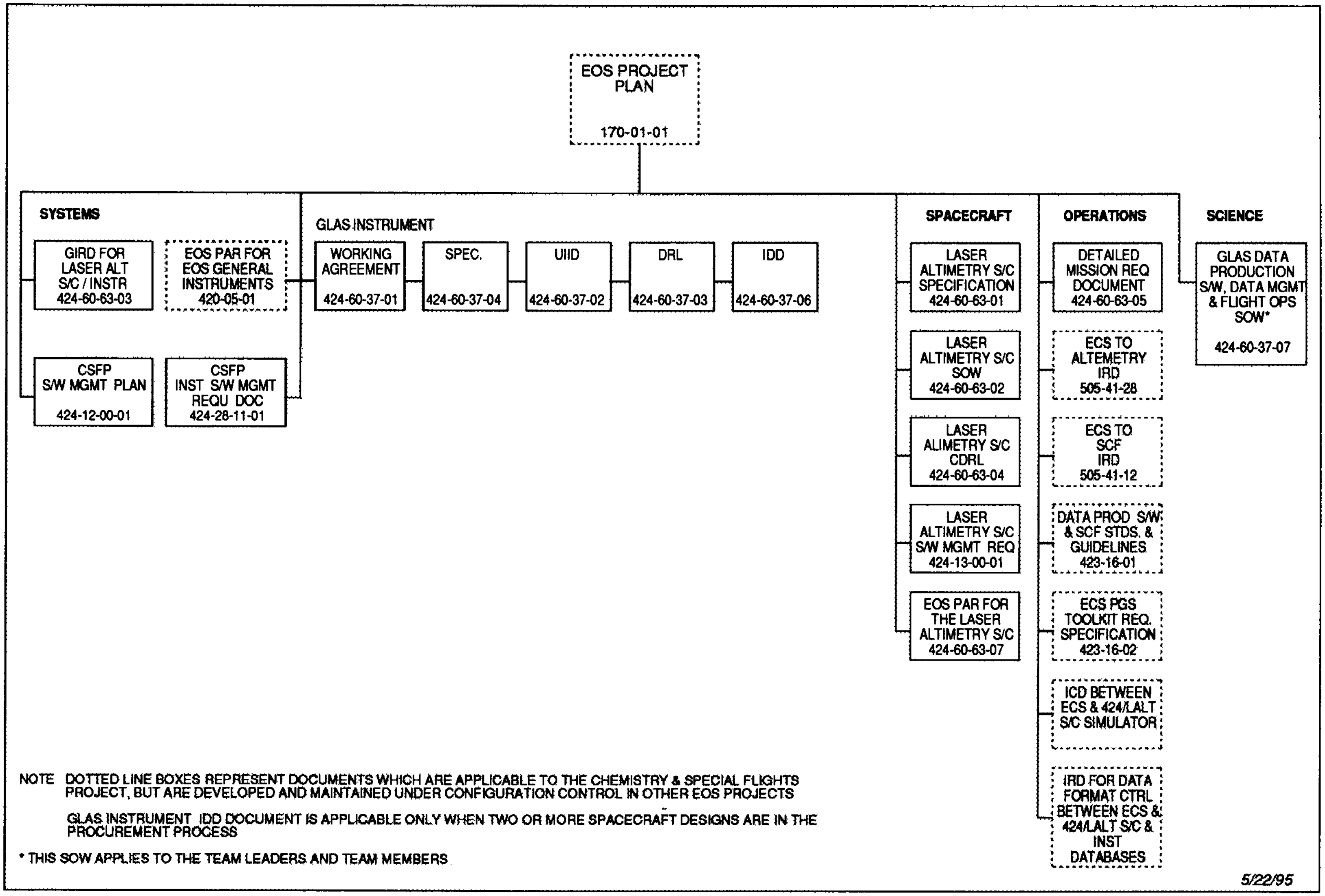

Figure 2.1-2 CSFP Laser Altimetry Documentation Tree

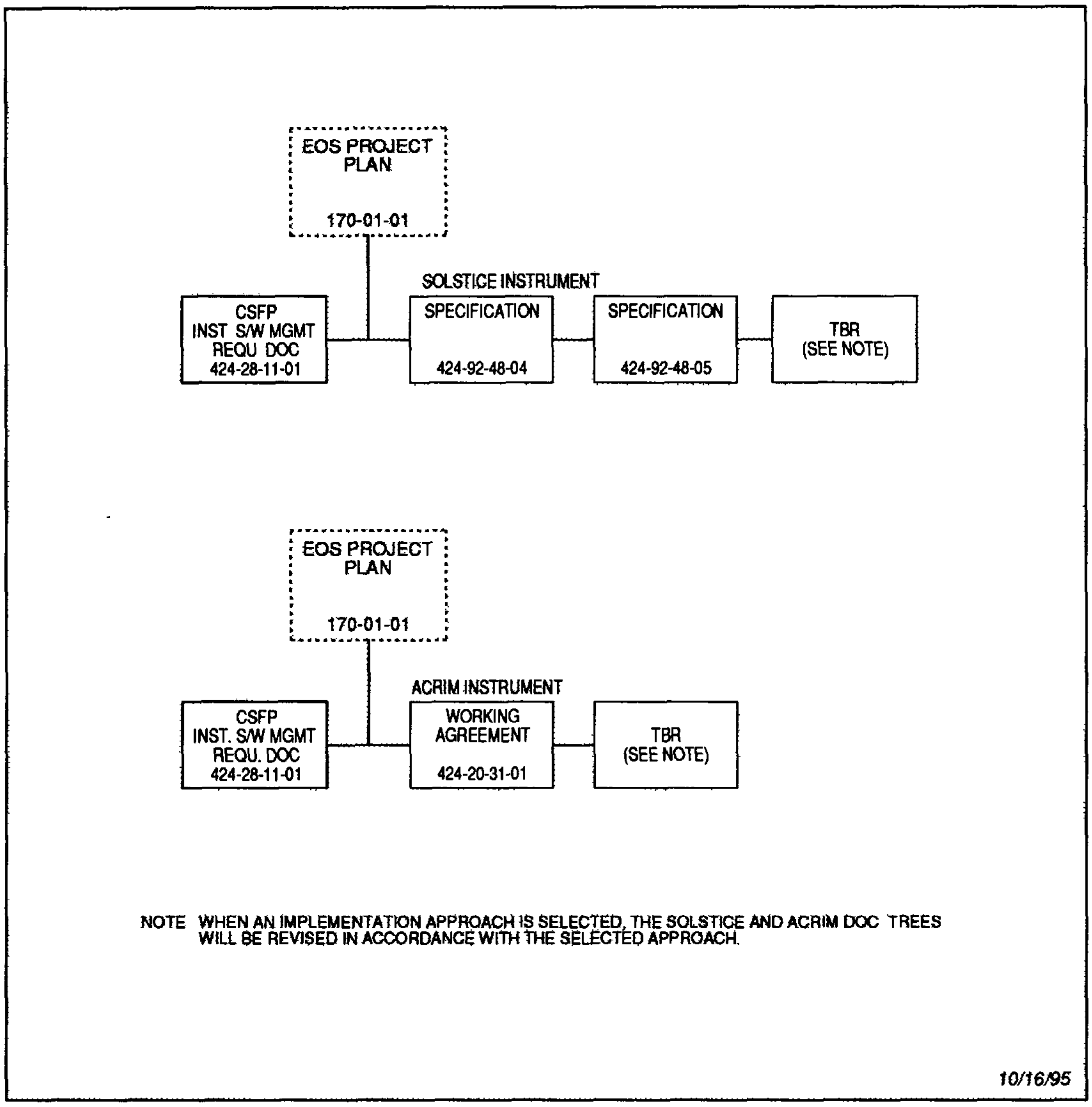

Figure 2 1-3 CSFP Flights of Opportunity Documentation Tree

[2.2-12]	GSFC 420-05-04	Performance Assurance Requirements (PAR) for the EOS Common spacecraft (Section 10), January 3, 1994.
[[2.2-13]	GSFC 420-05-01	Performance Assurance Requirements (PAR) for EOS General Instruments, Revision A, August 2, 1991.
[2.2-14]	GMI 8040.1A	Configuration Management, April 4, 1975.

2.3 INFORMATION DOCUMENTS

The following documents provide guidance that will assist the Project in managing the software acquisition process per this SMP.

[2.3-1]	GSFC-420-02-03	Project Configuration Management Procedures Handbook, Revision A, January, 1993
[2.3-2]	SMAP-GB-A201	Software Assurance Guidebook, September 1989

[2.3-3]	SMAP-GB-A301	Software Quality Assurance Audits Guidebook, November 1990
[2.3-4]	SMAP-GB-A302	Software Formal Inspections Guidebook, August, 1993
[2.3-5]	SEL-84-101	GSFC Software Engineering Laboratory, Manager's Handbook For Software Development, November 1990
[2.3-6]	SEL-81-305	GSFC Software Engineering Laboratory, Recommended Approach to Software Development, June 1992.
[2.3-7]		Guidelines for Standard Payload Assurance Requirements (SPAR) for GSFC Orbital Projects, Change 3, May 1992.
[2.3-8]	GHB 5112.1	Performance Measurement System (PMS) Handbook, August 1988.

2.4 OTHER REFERENCED DOCUMENTS

[2.4-1]	GSFC-505-16-04	ESDIS Science Software Management Plan, TBD.
[2.4-2]	GSFC-422-13-11-04	EOS Common Spacecraft Software Management Requirements, January 10, 1994
[2.4-3]	GSFC-422-11-12-01	General Interface Requirements Document (GIRD) for EOS Common spacecraft and Instruments, January 1994.
[2.4-4]	GSFC-422-13-11-01	EOS Common Spacecraft Specification, August 1994.
[2.4-5]	GSFC-422-13-11-02	EOS Common Spacecraft Statement of Work, August 1994.
[2.4-6]	GSFC-505-16-05	ESDIS Software Management Plan, TBD.
[2.4-7]	GSFC 424-28-11-01	CSFP Instrument Software Management Requirements Document (ISMRD), March 31, 1995.
[2.4-8]	GSFC 423-16-01	ESDIS Data Production Software & Science Computing Facility (SCF) Standards & Guidelines, January 1994.

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SECTION 3.0 - PURPOSE AND DESCRIPTION OF PROJECT SOFTWARE

This section provides an overview description of the software elements related to the Project. From the perspective of the Project, the management responsibility and approach differs among these various software elements. Section 3.1 describes software for which the budget, procurement, and management is controlled by the Project Section 3.2 describes software whose budget, procurement, and management is divided between the Project, other NASA centers, and international partners, depending upon the instrument. The responsibility for the software described in Section 3.4 also belongs to the Project, with the additional management participation of the Earth Sciences Data and Information System (ESDIS) Project. Section 3.3, with the exception of section 3.3.1.1.4, describes the software elements that are the responsibility of other Projects or Codes. These software elements will interface with those found in Sections 3.1, 3.2, and 3.4. The EOS CSF Project will have insight into these elements' development and will monitor their status but will have no direct management control over their development.

3.1 SPACECRAFT SOFTWARE

The spacecraft software is the responsibility of the Project and shall be provided by the spacecraft provider. It consists of the software elements in the following sections. These elements, categorized for management purposes, are broadly defined based on functionality. Interdependencies and commonalities that affect development and operations exist among the elements.

3.1.1 Spacecraft Flight Software

The spacecraft flight software is real-time software and firmware found in the on-board spacecraft microprocessor(s) and embedded in the various spacecraft hardware subsystems. It may include a vendor supplied operating system or kernel, and special purpose diagnostics. The general purpose of the spacecraft flight software is to provide the functions of spacecraft monitoring, control, and autonomy; guidance, navigation and control; spacecraft internal communication bus control; and ground operations interface.

3.1.2 Spacecraft Ground Support Equipment (GSE) Software

The GSE software supports the Integration and Test (I&T) of the spacecraft and instruments. For Chemistry, it includes the Operations and Science Instrument Support (OASIS) software package developed and maintained by the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado in Boulder. This package provides the capabilities for command generation, telemetry processing, limit checking, and display functions. OASIS operates from user-defined databases for the spacecraft and instruments, which are later integrated into a single spacecraft database. OASIS supports the Colorado Standard Test and Operations Language (CSTOL) which is the language used to write automated or interactive test procedures. In addition to OASIS, GSE software includes any special purpose software in ground test equipment such as attitude actuator and sensor simulators, sensor stimulators, trend analysis, and high and low data rate test equipment. The I&T system for missions other than Chemistry has not yet been selected.

3.1.3 Spacecraft Software Development and Validation (SDV) Software

The SDV software supports the development, test, and maintenance of the flight and GSE software. It includes host development computer operating systems, high level language compilers and debuggers, machine language emulators, and test scenarios and procedures. It includes the software in the spacecraft simulator, referenced later as the EOC Training Simulator, which models the sensors, actuators, and attitude environment and dynamics. It also includes development support software such as document and code configuration management systems, and Computer-Aided Software Engineering (CASE) tools.

3.2 INSTRUMENT SOFTWARE

The instrument software is the responsibility of the Project. The software is procured and managed by the respective Responsible Agencies (see section 1.0). The software consists of elements described in the following sections. These elements, categorized for management purposes, are broadly defined based on functionality. Interdependencies and commonalities that affect development and operations exist among the elements.

3.2.1 Instrument Flight Software

The instrument flight software is real-time software and firmware found in the on-board instrument microprocessor(s). It may include a vendor supplied operating system or kernel, and special purpose diagnostics. The general purpose of the instrument flight software is to provide the functions of instrument monitoring, control, and autonomy; spacecraft interface; and ground operations interface.

3.2.2 Instrument Ground Support Equipment (IGSE) Software

The IGSE software supports the integration and test of the instrument both before and after its installation on the spacecraft. It provides the capabilities for command generation, telemetry processing, science data processing, limit checking, and display functions. It may include the OASIS GSE software. During spacecraft integration, it includes a validated OASIS instrument database and validated instrument test procedures in the CSTOL language. IGSE software also includes any special purpose software in ground test equipment.

3.2.3 Instrument Software Development and Validation (ISDV) Software

The ISDV software supports the development and test of the flight and IGSE software. It includes host development computer operating systems, high level language compilers and debuggers, machine language emulators, and test scenarios and procedures. It includes any instrument simulator software which models the performance of the instrument or its science data. It includes any analysis software to validate the instrument engineering or science telemetry. It also includes development support software such as document and code configuration management systems.

3.3 GROUND SYSTEM SOFTWARE

3.3.1 EOS Data and Information System (EOSDIS) Core System (ECS) Software

The ECS software is the responsibility of the ESDIS Project. It consists of the software elements described in the following sections. This section provides an overview of the functions to be acquired by the ESDIS Project. The overview is intended for background information only. It is not intended to be used as functional requirements for the operations software.

3 3 1.1 FLIGHT OPERATIONS SEGMENT (FOS)

The FOS is composed of the EOS Operations Center (EOC) at GSFC and remotely located Instrument Support Terminal (IST) toolkits.

3.3.1.1 1 EOC

The EOC will perform all EOS spacecraft subsystem operations and operations coordination for its instrument complements. The EOC will provide monitoring of spacecraft health and safety, mission planning and scheduling, spacecraft commanding, instrument command support, and overall mission operations. The EOC will operate most instruments in coordination with instrument personnel using ISTs.

3.3.1 1 2 IST Toolkit

Instrument Principal Investigators (PI)s and Team Leaders (TL)s are ultimately responsible for the operation of their instruments. They participate in the operation of their instruments remotely, through an IST. A software toolkit implemented on an investigator workstation will provide the IST basic functionality. The IST gives the investigator access to data and displays from the EOC, and allows an investigator to generate and send instrument activity schedules to the EOC as appropriate. The IST can also support instrument planning and scheduling, health and safety monitoring, performance monitoring, sustaining engineering, and anomaly investigation.

3 3 1.1.3 ICC Software

The EOS ground segment will establish ICCs only as needed. For the AM-1 flight, there will be only one ICC (to support ASTER), which will be located in JAPAN.

ICC functions for operationally non-complex instruments will be performed through the EOC and through use of an IST.

3.3.1.1 4 Spacecraft Simulator Software

The software provided by the spacecraft provider that resides in the Spacecraft Simulator is composed of software components already described in sections 3.1.2 and 3.1.3. This Spacecraft Simulator is often referenced as the EOC Training Simulator. The software models the sensors, actuators, instruments, and any other spacecraft hardware which is not resident in the facility. It also models the attitude environment and dynamics. The ground system software interface shall be the EOC environment rather than the I&T (OASIS) environment of section 3.1.2.

3.3.1.2 SCIENCE DATA PROCESSING SEGMENT (SDPS) SOFTWARE

The science data processing software is the responsibility of the ESDIS Project. It consists of the software elements described in the following sections. The following sections provide an overview of the functions to be acquired by the ESDIS Project. The overview is intended for background information only. It is not intended to be used as functional requirements for the data processing distribution software.

3 3 1.2.1 Product Generation Software

The Product Generation services provide the infrastructure for EOS science data product generation services. These services include (1) scheduling and control of product generation, (2) collection of resource ınformation for Communications and Systems Management Segment (CSMS), to enable load leveling, (3) providing resources and management to generate products, (4) providing post-production quality assessment, and (5) test and integration of scientist-developed science data production software.

3.3 1 2.2 Data Archive and Distrıbution Software

The Data Archive and Distribution services provide the infrastructure for EOS data management services. These services include (1) ingest methods for storing and indexing EOS data, (2) long-term reliable storage and retrieval, (3) processing of orders for all archived data and (4) distribute data electronically and on computer processed media.

3.3.1 2 3 Information Management Software

The Information Management services provide a common user interface (human-machine and computer-to-computer) for ECS services and to ECS-provided software packages. These interfaces provide the ability to locate EOS data based on metadata parameters (e.g., time, location, sensors), and to provide browse date for further refinement of the search. The interfaces also provide the ability to (1) request data from the archive, (2) request the generation of higher level products, (3) request the collection of specific data, (4) determine the status of any request and (5) see estimated cost(s) before ordering.

3 3.1 3 COMMUNICATIONS AND SYSTEMS MANAGEMENT SEGMENT (CSMS) SOFTWARE

The CSMS software provides the infrastructure for EOS system and network management. One CSMS software component, the EOSDIS Science Network (ESN) provides basic connectivity and communications services within the distributed ECS components and between ECS and EOSDIS components. In addition, the System Management Center (SMC) (1) maintains and operates the ECS infrastructure of local computing resources at distributed sites, (2) provides coordination of all ECS facilities and (3) troubleshoots any multi-location communications problems.

3.3.2 EDOS/EBNET Software

The EOS Data and Operations System (EDOS) software provides two-way communications of commands and data. EDOS passes commands and data to the White Sands ground stations and receives downlink telemetry from the ground stations for decoding, packet recovery, level-0 processing and transmission to the appropriate DAAC(s).

The EOSDIS Backbone Network (EBNET) software manages and controls the circuits, switching and terminal facilities to provide operational telecommunications support. It supports (1) a variety of bandwidths, (2) the data transport paths from the EDOS elements to the DAACs and EOC, (3) state-of-the-art communications methods (e.g., fiber optics, domestic communications satellites) and (4) interfaces with other NASA, government and commercial networks.

3.4 SCIENCE TEAM SOFTWARE

The science data generation software is the responsibility of the science teams for the respective instruments. The Project, along with the ESDIS Project, provides the software management for all of the instruments. The science data generation software is composed of the elements described in the following sections.

3.4.1 Science Data Generation Software

This section provides an overview of the science data generation functions to be developed by science teams and acquired by the Project. The software will produce scientific data products from downlink telemetry for the EOS CSFP instruments.

3 4 1.1 LEVEL-1 SCIENCE DATA GENERATION SOFTWARE

The function of the Level-1 (L-1) science data generation software is to provide geolocated, calibrated, and radiometrically corrected data. The L-1 software receives input Level-0 raw instrument data at original resolution, time ordered, duplicates removed, from the EOS Data and Operations System (EDOS) and ancillary or supporting data from a variety of sources.

3.4.1.2 LEVEL-2 SCIENCE DATA GENERATION SOFTWARE

The function of the Level-2 (L-2) science data generation software is to provide geophysical variables at L-1 resolution. The L-2 software receives L-1 data and ancillary or supporting data from one or more Distributed Active Archive Centers (DAACs).

3 4 1 3 LEVEL-3 SCIENCE DATA GENERATION SOFTWARE

The function of the Level-3 (L-3) science data generation software is to provide resampled data. The L-3 software receives as input L-1 and/or L-2 data and ancillary or supporting data from one or more DAAC s.

3.4 1.4 LEVEL-4 SCIENCE DATA GENERATION SOFTWARE.

The function of the Level-4 (L-4) science data generation software is to perform data modeling, aggregation, and/or (sub)sampling that result in derived geophysical parameters. The L-4 software receives as input L-1, L-2 and/or L-3 data and ancillary or supporting data from one or more DAACs.

3.4.2 Instrument Calibration Software

The instrument calibration functions to be developed by instrument developers and acquired by the Project will provide calibration data and parameters for the EOS CHEM instruments so that instrument counts may be reliably converted to filtered radiances in engineering units and/or geophysical parameters. These data and parameters are then incorporated into the appropriate data production software and tables.

3.5 CONTROLLING DOCUMENTS

The following table shows the highest level controlling document for each of the major software types defined above:

SOFTWARE TYPE	ACQUIRER	PROVIDERS
CHEMISTRY SPACECRAFT SOFTWARE		
S/C FLIGHT S/W	424 SMP	422 PM SMRD
S/C GSE S/W	424 SMP	422 PM SMRD
S/C SDV S/W	424 SMP	422 PM SMRD
ALTIMETRY SPACECRAFT SOFTWARE		
S/C FLIGHT S/W	424 SMP	TBS
S/C GSE S/W	424 SMP	TBS
S/C SDV S/W	424 SMP	TBS
INSTRUMENT SOFTWARE		
INSTRUMENT FLIGHT S/W	424 SMP	424 ISMRD / GIRD
INSTRUMENT GSE S/W	424 SMP	424 ISMRD / GIRD
INSTRUMENT SDV S/W	424 SMP	424 ISMRD / GIRD
SCIENCE SOFTWARE	424 SMP / ESDIS SCIENCE SMP	SCIENCE SOWs / WORKING AGREEMENTS

Table 3.4-1 Controlling Software Documents for CSFP Missions

Notes:

424 SMP	=	EOS Chemistry & Special Flights Project Software Management Plan (this document)
422 PM SMRD	=	EOS Common Spacecraft Software Management Requirements [ref 2.4-2]
424 ISMRD	=	EOS Chemistry & Special Flights Project Instrument Software Management Requirements Document [ref 2.4-7]
GIRD	=	General Interface Requirements Document (GIRD) for EOS Common spacecraft and Instruments [ref 2 4-3]
ESDIS SCIENCE SMP	=	ESDIS Project Science Software Management Plan [ref 2 4-1]
SCIENCE SOWs	=	Science Activities SOW (developed by IM for each instrument)
WORKING AGREEMENTS	=	CSFP Science Working Agreements

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SECTION 4.0 - RESOURCES, BUDGETS, SCHEDULES, AND ORGANIZATIONS

This section describes the Project organization and the management aspects of software acquisition for the EOS CSFP spacecraft and any instrument for which the Project has been designated as the management entity with GSFC/CSFP Project as the Responsible Agency. This section discusses how the Project will oversee the management of resources, cost and schedule, utilizing the data that the spacecraft and instrument providers are contractually bound to provide.

With regard to all other instruments comprising the Project, the basic responsibility for managing the business aspects lie with the Responsible Agency overseeing the instrument development. The responsible GSFC Instrument Manager (IM) has oversight responsibility in these areas. The SSM's role with regard to those particular instruments' business management is solely to support the IM, as requested.

4.1 BUSINESS PRACTICES DEFINITION AND REVISION PROCESS

The Project will generate in-house cost estimates and schedules, and will require providers to estimate costs and schedules in parallel. The Project estimates will be used to validate those of providers; negotiated provider costs and schedules will be part of the agreements between the Project and its providers. The project requires reporting from each provider that includes expenditures and progress. These reports will be used by the Project to manage the business related aspects of the software acquisition process and to assess technical progress.

4.1.1 Definition of Activities

The activities that the Project will use to manage the business related aspects of each provider are:

- Estimation and re-estimation of cost and schedule.
- Tracking of costs.
- Assessment of technical progress and schedule.

4.1.2 Method and Approach

The Project will independently develop estimates of resources, cost, and schedule for the contractors, based on the applicable Work Breakdown Structure (WBS) or working agreement, to compare with and validate the initial estimates received from each software provider. In addition, the Project will prepare a Master Schedule, to be used by each provider, for delivery of all products. The Project will, after negotiation with the contractors, agree on a WBS breakdown of cost and schedules. The Project will assess progress against the agreed WBS resource profiles and schedules by evaluating provider monthly progress reports as defined in section 4.1.3.

In addition to the reports defined in section 4.1.3 the Project may use contractor monthly reviews for monitoring the progress and tracking possible problems/concerns of software. Problems identified will be addressed with the provider. Solutions to problems may result in contract changes processed through the CM system and the

Contracting Officer (CO), or in technical direction to the provider by the Contracting Officer's Technical Representative (COTR) depending on the scope and impact of the solution.

4 1.2.1 INITIAL AND REVISED ESTIMATES OF RESOURCES AND SCHEDULE

The following cost estimation strategies will be used (where possible or practical) by the Project for the spacecraft, and future contracts prior to contract award:

(a) A grass-roots estimation based on first-hand experience with software systems using development team personnel, labor hours, and resource costs. Assumptions regarding estimated lines of code, available heritage code, COTS software availabilty, development and test support tools for the projected processor, experience of software personnel, and development practices/approaches used by the providers will be formalized.

(b) A commercial or government cost estimation program based on the Constructive Cost Model (COCOMO), or an equivalent model. The same assumptions which were formalized for the grass-roots estimation will be used in the Model to confirm the validity of these estimations.

(c) The grass-roots estimation will be utilized at contract negotiations in determining a final contract cost.

After contract award, the negotiated contract costs will be used in the monitoring of contract progress. The baseline will be updated accordingly based on approved changes to schedule and scope of the software elements, and at major reviews throughout the project life-cycle. As metrics are garnered from the provider (see sections 4.1.3.1 and 5.3.3.8) they will be folded into the baseline to extract a more current and accurate estimate. The level of metric data is specified in the individual contracts. An example of the increasing accuracy of the metric data can be found in the common spacecraft contractor's requirements. Metric data will be provided by the contractor at the Computer Software Configuration Item (CSCI) level at project start-up through the Requirements phase. From that point through Preliminary Design the metrics will be reported at the Computer Software Component (CSC) level. From there through contract completion, all metric data will be reported at the Computer Software Unit (CSU) level. This fine detail of reporting will allow the Project to maintain accurate estimates of progress of the software WBS elements. This data will continue to be used in monitoring and managing subsequent spacecraft and instruments.

4.1.2 2 PROGRESS ASSESSMENT

The Project will assess progress of the provider's efforts against both the Master Schedule maintained by the Project and against detailed schedules supplied by the provider. Technical progress will be assessed monthly. All problems and risks will be discussed with the provider and corrective action agreed upon where required. The SSM will support software status presentations to assess the state of all software elements and to raise first-hand any concerns or questions with the provider's Software Manager.

4.1.2.3 MANAGEMENT REVIEWS

The Project will assure that each formal review as defined in the Software Review sections of the appropriate Performance Assurance Requirements (PAR) document (or as negotiated with the provider) is accomplished according to schedule. Based on the material presented by the provider at each of these Reviews, the Project will assess the current status of the provider's software accomplishments. The assessed state of technical accomplishment will be evaluated against the planned and actual expended staff-hours, available resources, and schedules. If cost, resource, or schedule profiles are more than 10% out of line with those established for the current point in the development process, the Project will review and analyze the provider's approach to recovering the schedule, cost, and/or resource shortfalls based on prior performance, criticality of work, resources available, etc.

4.1.3 Reporting, Monitoring, and Revision

The Project will utilize contractually required management reports to assist in monitoring the technical progress, cost, resources, and schedules of development for all software WBS elements. These reports are in addition to software development life-cycle documentation that is discussed in later sections of this Plan.

4.2 WORK BREAKDOWN STRUCTURE (WBS)

The following sections describe the software WBS of the Project's directly contracted activities

4.2.1 Activity Definition

The WBS for the EOS Common spacecraft is described in the PMS Database and shown in Figure 4.2.1-1. The CHEM WBS numbers are obtained by substituting 3 for letter X in this diagram. The level 3 elements of this WBS are described below:

(a) Software Management - includes the development and administration of all software planning documents, management and control board meetings, and management audits used with spacecraft development and instrument accommodation.

(b) Flight Software - Refer to section 3.1.1 for an overview

(c) GSE Software - Refer to section 3.1.2 for an overview

(d) SDV Software - Refer to section 3.1.3 for an overview

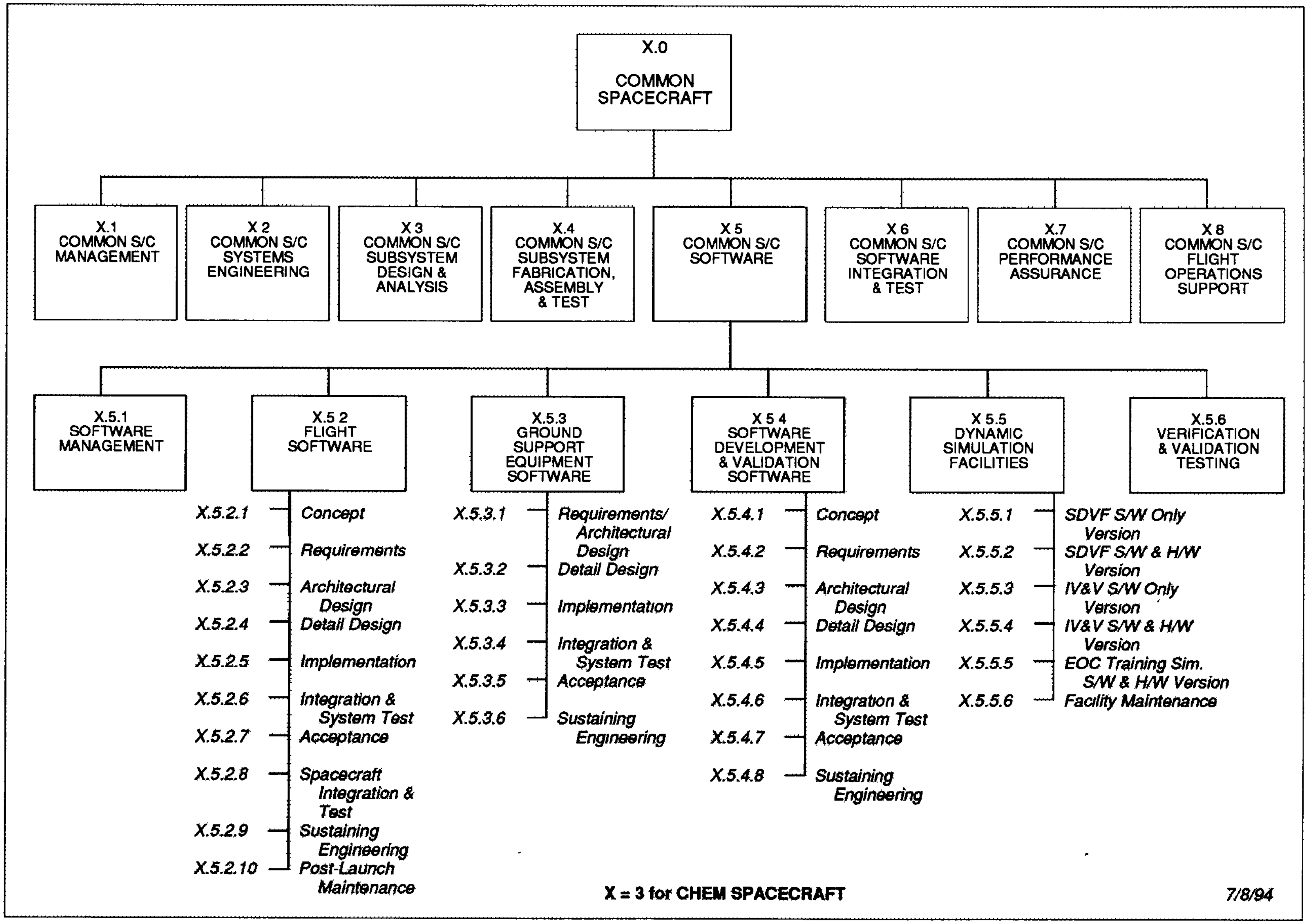

Figure 4.2.1-1 CHEM Spacecraft Software Work Breakdown Structure

(e) Dynamic Simulator Facilities - includes the effort to provide all resources necessary to develop, verify, and maintain through the on-orbit life of the CHEM spacecraft, any CHEM mission-unique elements of the common spacecraft dynamic simulator facilities including any modifications required for follow-on spacecraft and instrument accommodation. This includes the effort to supply all hardware, COTS software and installation for the three facilities. Reference section 3.3.1.1.4 of this document and section 4.3.3 of the EOS Common Spacecraft Software Management Requirements Document (SMRD) [ref. 2.4-2] for additional information concerning these facilities along with exceptions to the facilities' maintenance.

(f) Software Verification and Validation Testing - includes the effort to provide all resources necessary to support verification and validation testing of all mission-unique software developed for the CHEM spacecraft including any modifications required for instrument accommodation.

The WBS for the various instruments are negotiated with the respective instrument builders, and maintained in PMS (or equivalent) databases by the various contractors, and are not repeated here.

4.2.2 Cost Account Definition

N/A

4.3 RESOURCE ESTIMATION AND ALLOCATION TO WBS

This section lists and describes the resources available to support the management of the provider's activities by the Project.

4.3.1 Schedules

The preliminary version of the Level II Project Master Schedule is included in the Execution Phase Project Plan. More detailed schedules developed by spacecraft and instrument contractors and software providers shall conform to the approved Master Schedule. It is the intent of the Project to use the contractors' in-house schedule system as the mechanism for reporting schedule status with the provisions as stated in the appropriate Contract Data Requirements List (CDRL).

Schedules will be reported and reviewed by the Project on a monthly basis as part of monthly reports. The schedules and their updates will contain major project milestone events and software provider reviews and deliveries that have been established by agreement between the Project and the provider. The Project will receive the schedules in both a hard-copy and electronic format.

The SSM will maintain a more detailed Software Management schedule to include all milestones and significant events (e.g., documentation releases, reviews, software releases) required to meet the Project Master Schedule events, to the lowest levels of the WBS using input from the monthly progress reports.

Changes that impact the Software Management schedule but not the Level II Project Master Schedule will be monitored through the provider's monthly management reports. Proposed software changes that impact the Project Master Schedule will be controlled by the Project as Class I change requests as required by section 10.4.b of the spacecraft PAR and section 2.2.2 of the EOS Configuration Management Plan.

The SSM will monitor the schedules of the Ground System and Science Team software Elements (described in section 3) for impacts to the Level II Project Master Schedule and the Software Management Schedule.

4.3.2 Funds and Budgets

N/A

4.3.3 Organization

The multiple project structure within the MTPE office requires effective management of roles and responsibilities in order to avoid duplication of effort or misdirected effort. The areas of primary and supporting responsibility are discussed below.

The primary responsibility for the EOS common spacecraft system and software definition belongs to the EOS PM Project with support from the EOS CSF Project and EOS AM Project. The PM Project SM is the point of contact for the PM Project in this area. The CSF Project SSM will have primary responsibility for any aspects of the CHEM spacecraft software (as defined in Section 3.1) which are uniquely developed to support CHEM requirements.

Financial and technical management of instrument software (as defined in Section 3.2) is the responsibility of the designated IM with support from the SSM as required.

Science software (as defined in Section 3.3) associated with an instrument is the responsibility of the IM with technical support from the SSM and the ESDIS Science Software Manager.

The FOS being developed by the ESDIS Project will be operational for the EOS AM spacecraft, but must subsequently meet the pre-launch test and post-launch operations of the EOS PM, EOS Chemistry, and EOS AM-2 spacecraft. Each project is responsible for conveying their software requirements through Inter-Project Working Agreements and other (TBD) mechanisms. The SSM is the point of contact for the CSF Project in this area.

The CSF Project will have an MOU with the Flight Software Systems Branch (FSSB, Code 512) for software IV&V support, and for post-launch maintenance of the spacecraft and SDV software. The SSM is the point of contact for the CSF Project in this area.

The CSF Project's organizational structure is shown in Figure 4.3.3-1.

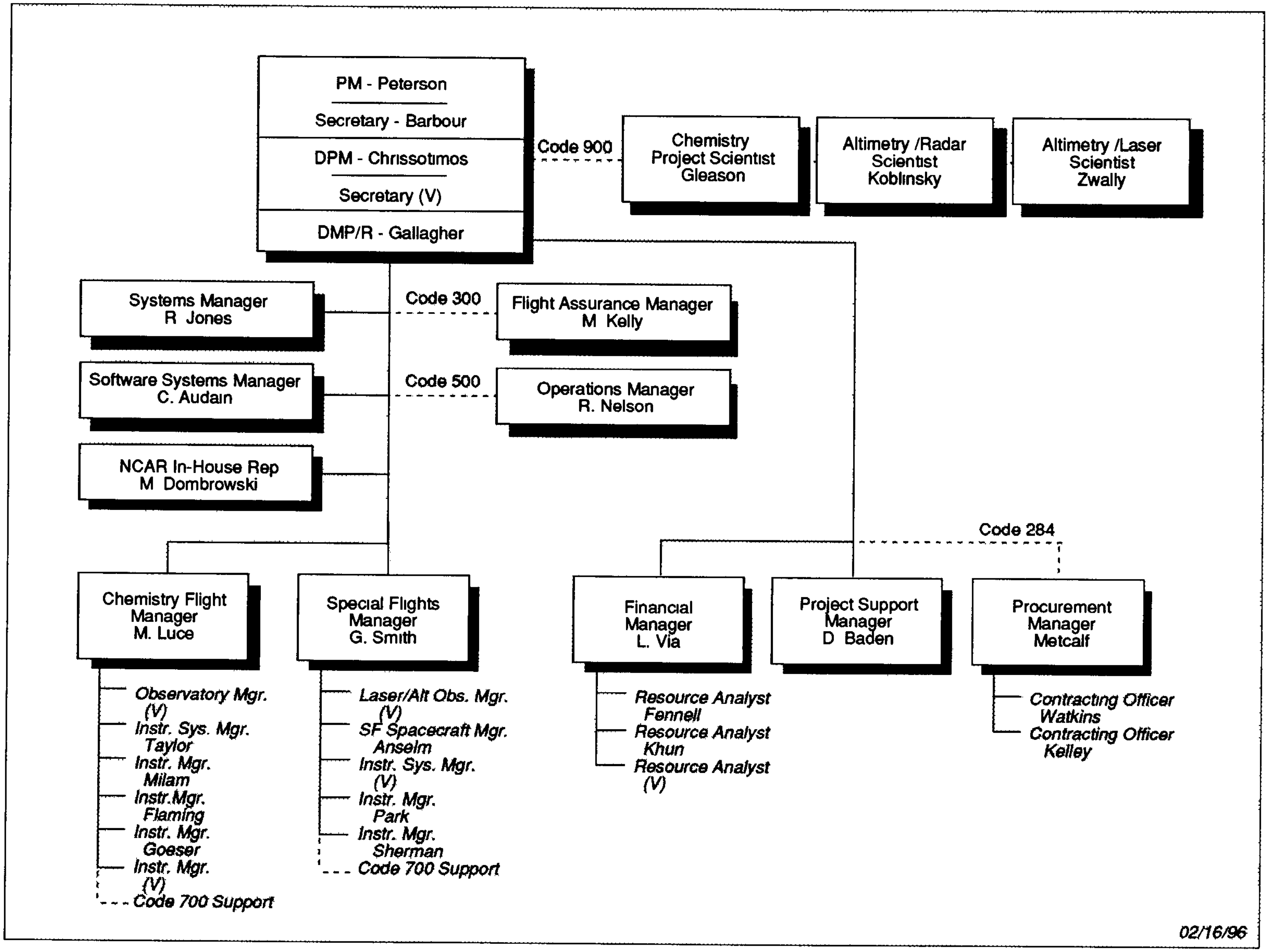

Figure 4.3.3-1 Project Organization Structure

The following sections describe the responsibilities of Project members with major software roles.

4 3.3.1 CSFP PROJECT MANAGER

The EOS CSFP Project Manager (PM) has overall responsibility for the project execution. The PM is responsible to the Director of Flight Projects, the Director of the Mission to Planet Earth Office, and the Director of GSFC. The PM discharges the responsibilities with the assistance and support of individuals and organizations assigned either administratively or functionally to the Project.

4.3 3 2 CSFP DEPUTY PROJECT MANAGER

The Deputy Project Manager (DPM) is responsible to the Project Manager and provides technical management of Project personnel and activities on a day-to-day basis. In the absence of the PM, the DPM assumes full responsibility for the project.

4.3 3 3 CSFP SYSTEMS MANAGER

The Systems Manager is responsible to the PM for all systems aspects of the flight and ground segments, including flight and ground software and firmware.

4.3 3 4 CSFP SOFTWARE SYSTEMS MANAGER (SSM)

The SSM is responsible to the Project Manager for the successful management of the Project's acquisition of software that meets requirements and is delivered on schedule and within budget. These responsibilities include the development and maintenance of this document, i.e., the Project's Software Management Plan. The responsibilities of the SSM also include, but are not limited to, the following:

(a) Serving as the focal point for all matters pertaining to the acquisition of software and working with the appropriate COTR when technical direction or contract changes are required.

(b) Serving as the award fee Event Monitor for all CSF software as descrıbed in section 5.3.1.

(c) Reviewing Providers' SMPs and havıng SMP approval authority where Project approval is required.

(d) Ensuring that at the conclusion of each life cycle phase, re-estimations of software size, effort, and schedule are made and analyzed.

(e) Attending spacecraft, instrument, and science software reviews and status meetings, and serving as co-chairperson at all software life cycle phase transition reviews. The SSM will ensure that all review items are documented in the Software Review Reports and tracked via the Monthly Progress Reports until resolved by the provider.

(f) Determining, upon completion of a review, whether the software life cycle phase has been successfully completed. If so, the SSM will recommend to the COTR that the provider begin work on the next phase.

(g) Monitoring provider software staffing and staff changes to ensure continuity and sufficiency of expertise to meet schedule requirements.

(h) Reviewing progress reports from providers (as specified in section 4.1.3). The reports will present current status, accomplishments for the reporting period, planned achievements for the next period, and issues, problems and concerns. Using the information in the reports, the SSM will identify software management problems to be resolved with the providers.

(i) Monitoring the products and processes of any provider's software subcontractors to ensure end-to-end quality. Management of subcontractors is a contractor responsibility.

(j) Participating in the Interface Working Groups (see section 5.4.7.2) which are responsible for the development and maintenance of Interface Requirements Documents (IRDs) and Interface Control Documents (ICDs) relating to spacecraft or instrument software.

(k) Serving a key role in the planning and operation of any OASIS Working Group which will include EOS CHEM spacecraft contractor personnel, instrument contractors, OASIS system developers, and personnel from other EOS projects.

(l) Interfacing with the various Instrument and Spacecraft Managers concerning issues surrounding the development of software.

(m) Providing Project oversight responsibility with regard to software integration and test, and verification and validation work performed in conjunction with the spacecraft software provider.

(n) Assuring that the Project responsibilities as listed in the MOU between the Project and FSSB are carried out. The SSM will be the Project point of contact for software technical issues which must be addressed by both the IV&V effort of the FSSB and the V&V effort of the spacecraft software provider. The SSM will facilitate the exchange of information between the two groups.

(o) Managing the Project's software support contractors and any co-located members of the FSSB who are assigned to the project.

(p) Interfacing with Project personnel in the areas of software assurance and configuration management, as detailed in Sections 8 and 10, in order to more effectively manage the development of software by the spacecraft software provider. In support of this effort the SSM will utilize reports and status information as provided by other members of the Project (i.e., SAM, CMO). to monitor the progress and issues surrounding the software development.

(q) Interfacing with ESDIS science software manager concerning issues surrounding the development of science software.

4 3.3 5 CSFP FLIGHT MANAGERS

Each of the CSFP flights (CHEM, Special Flights) is assigned a Flight Manager. The Flight Managers are responsible to the PM for management of a series of spacecraft (typically launched on 6-year centers) within a particular flight series (e.g., the CHEM series).

4.3.3 6 CSFP OBSERVATORY MANAGERS

Each of the CSFP spacecraft (e.g., CHEM-1, Laser ALT) is assigned an Observatory Manager. The Observatory Manager is responsible to the Flight Manager for management of the development of a single spacecraft, and its instrument complement.

4.3 3.7 CSFP SPACECRAFT MANAGERS

The Spacecraft Manager is responsible to the Flight Manager for management of the development of a single spacecraft.

4.3.3.8 CSFP INSTRUMENT SYSTEMS MANAGERS

Each of the CSFP spacecraft (e.g., CHEM-1, Laser ALT) is assigned an Instrument Systems Manager. The Instrument Systems Manager is responsible to the Flight Manager for management and coordination of all instruments belonging to a particular flight series.

4.3.3 9 CSFP INSTRUMENT MANAGERS

Each of the CSFP instruments is assigned to an Instrument Manager. The IMs are responsible to the Instrument Systems Manager for the development of one or more instruments, including the development of instrument flight software, instrument-related GSE and SDV software, and instrument-related science software. For international instruments, the IM's role may be limited to oversight and coordination.

4.3 3.10 OPERATIONS MANAGERS

An Operations Manager (OM) from the ESDIS Project (Code 505) is assigned to each CSFP flight mission to ensure that operational concepts and planning are consistent across CSFP flight missions, and that these activities are compatible with ESDIS Project flight operations concepts and plans.

4 3.3.11 CSFP FLIGHT ASSURANCE MANAGER

The Flight Assurance Manager (FAM), from the Assurance Management Office (Code 303), is responsible to the PM for all the disciplines to ensure that the spacecraft, instrument, and ground system hardware and software will meet their intended performance objectives. These disciplines include quality assurance (QA), design review, reliability, system safety and security, materials, processes, and verification testing.

4.3.3.12 CSFP SOFTWARE ASSURANCE MANAGER

The Software Assurance Manager is responsible to the FAM and the SSM for ensuring that provider software management, development, and assurance programs are being conducted according to the provider's approved Software Management, Development and Assurance Plans, and the applicable standards and procedures.

The SAM's responsibilities include but are not limited to:

(a) Planning and conducting the Project's software assurance program.

(b) Establishing the Project's software assurance requirements and procedures.

(c) Reviewing the software assurance sections of provider software plans and standards, and recommending changes and/or approval.

(d) Assuring that all software is being developed, procured, and tested according to the provider's software plans and standards.

(e) Assuring that reviewed documents and tested software are the current, correct versions.

(f) Assuring that the Project's Nonconformance Reporting and Corrective Action (NRCA) data base is established and kept current, and that all non-conformances are properly documented.

(g) Assuring that all changes to the software are made in accordance with approved software configuration management procedures.

(h) Providing the SSM with current reporting, status, and information concerning standards and assurance conformance and issues, audits and their outcome, and overall software development performance.

4.3.3 13 CSFP CONFIGURATION MANAGEMENT OFFICER

The Project Configuration Management Officer (CMO), as head of the Project's Software CM organization, is responsible to the PM and the SSM for establishing and maintaining the proper level of Project control over its products. Specific CMO responsibilities are to:

(a) Establish the Project's CM system.

(b) Establish and maintain the Project's Configuration Change Request (CCR) tracking data base.

(c) Review and maintain the Project's Software Configuration Management Plan section of the SMP.

(d) Review the provider's CM Plan(s) for conformance to Project Requirements and standards.

(e) Manage the software CM library and thereby control the use and revision of official copies of baseline components.

(f) Act as secretary to the Project's Configuration Control Board (CCB) by preparing and distributing its agendas and minutes, recording status of CCRs effected by CCB deliberations, and preparing Project change authorizations for CCB approved CCRs.

(g) Produce and distribute periodic CCR data base and individual product CCR status reports.

(h) Support Project functional and physical configuration audits (FCA & PCA) of providers.

4.3.4 Equipment

All equipment required to support the development of Project software will be listed in the provider's SMP. Section 3.1 contains requirements for Software Development and Validation (SDV) Software that includes CASE tools. Equipment for the SDV will be listed in the provider's SMP.

4.3.5 Materials, Facilities, and other Resources

Acquisition of the materials, facilities and resources required to accomplish the software tasks is the responsibility of the spacecraft, instrument, and ground system contractors. The Project requirements for each contractor can be found in the appropriate Statements of Work.

Agreements for the installation, operations, and maintenance of facilities delivered by Project contractors to GSFC will be formalized as listed below:

(a) A MOU between the Project and the FSSB will include the physical requirements for the IV&V Facility delivered by the spacecraft contractor.

(b) An ageement will be developed between the CSF Project and the ESDIS Project for the allocation of space and aspects of the physical plant required to house the EOC Training Simulator for the CHEM mission delivered by the spacecraft contractor.

Agreements for personnel resources from GSFC supporting organizations will be formalized as listed below:

(a) Software-related spacecraft subsystem support will be requested from the Flight Data System Branch of the Engineering Directorate each year in the form of GSFC Statements of Work.

b) SAM support will be requested from the Assurance Management Office on a yearly basis by the Project.

(c) The MOU between the Project and the FSSB will define the level of effort to be supplied by FSSB personnel for spacecraft software IV&V and post-launch maintenance.

All materials, facilities, and other resources, including the software portions of the SDV, required to support the development of the Project software will be listed and described in the provider's SMP.

4.3.6 Management Reserves

Budget reserves for the spacecraft software provider are under the control of the spacecraft contractor's Program Manager. Budget requirements over and above the negotiated contract value are under the control of the PM and the CO.

Budget reserves for the instrument software providers are under the control of the Responsible Agency managing the individual contracts.

Budget reserves for in-house Project resources are under the control of the EOS CHEM Deputy Project Manager/Resources.

4.4 WORK AUTHORIZATION

For the EOS CHEM spacecraft software provider, the Project will use the signed contract as the authorization to proceed with work. The work is as documented in the contract package, subject to any special contract requirements for other authorization processes. Authorization from the COTR is required before the provider can begin subsequent life-cycle phases for any software Element. This authorization is dependent on successful completion and approval of all activities and deliverable products of the previous life-cycle phase for the software Element in question.

For work that is in addition to the original contract, changes to the software, its interfaces, cost, resources, and schedule, the Project will review and assess the merits and impacts of the change once it is officially forwarded through the Project's CM system as required in Section 10. Upon a successful evaluation, the appropriate documents detailing all aspects of the contract modification or addition will be forwarded to the Contracting Office for official direction to the contractor. Only the CO may direct the commitment of Government funds and authorize additional work.

It is the intent of the Project to utilize Code 512, the Flight Software Systems Branch, to provide a number of long-term support functions with relation to the EOS CSFP missions. These functions include IV&V of selected portions of the Flight software Element for the EOS CHEM spacecraft. This Branch will also provide long-term software maintenance support for the Flight Software Element and the SDV Software Element. This maintenance will begin after early-orbit checkout of the EOS CHEM spacecraft. The scope and magnitude of this support will be detailed in a MOU between the Project and Code 512 management. Transfer of responsibility for the EOS CHEM spacecraft software provider is discussed in Section 11, Delivery and Operational Transition Plan.

For GSFC internal providers who are working under an agreement other than a contract, the PM shall authorize additional work or additional funds as required.

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SECTION 5.0 - ACQUISITION ACTIVITIES PLAN

This section of the SMP describes how the Project will manage the activities of software providers.

Software management requirements and constraints that are binding upon software providers, and standards that providers are to use in the development and assurance of software products are not specified in this document. These topics are addressed in the EOS Common spacecraft SMRD [ref. 2.4-2] (CSFP ISMRD [ref. 2.4-7] in the case of CSFP instruments). No SMRD exists for the science software; the software management requirements are contained in the respective SOW or working agreement.

5.1 PROCUREMENT ACTIVITIES PLANNING

Procurement planning information that supports the Project's acquisition of software by means of competitive contracts is sensitive data and must be controlled. It is inappropriate to include such information in a SMP that will be widely distributed and reviewed in public prior to the procurement. The topics of information identified by this section are included in controlled documents that are required by NASA's procurement policies and procedures. These sensitive documents are available only to authorized individuals.

5.1.1 Procurement Package Preparation

The SSM will prepare software management requirements documents which will be reviewed by the rest of the Project. For science software, the SSM, with the science SM, will be responsible for preparation of the science statement of work.

5.1.2 Proposal Evaluation

The Project SSM will contribute in a substantial way to the technical evaluation of the software portions of all proposals for spacecraft, instruments and science.

5.1.3 Contract Negotiation

The Project SSM will support the contract negotiation process to assure that all software related proposal weaknesses and deficiencies are corrected between the period of contractor selection and award of a given procurement.

5.1.4 Procurement Risks

The in-depth, "hands-on" participation of the Project SSM will lessen, as much as possible, any risks to the software budget and schedule within a given procurement.

5.2 ORGANIZATIONAL REQUIREMENTS AND LIFE CYCLE ADAPTATIONS

5.2.1 Business Practices, Resources, and Organizational Requirements

See section 4.1. for business practices and resources, and section 4.3.3 for Project organizational information.

5.2.2 Life Cycle Adaptations and Approved Waivers

Providers may use the NASA Software Acquisition Life Cycle, Release 4.3. Figure 5.2.21 shows a typical example of this life cycle. Provider-proposed adaptations to the life cycle, such as development by builds, incremental development and/or phased delivery, will be described in the provider's SMP. In proposing any adaptation, the provider will describe the reviews and their relationships to the life cycle phases, and the baselines to be struck at the completion of the reviews. The SSM will ensure that any proposed modifications to the life cycle phases and associated phase reviews will provide adequate management visibility into the development process. All adaptations will be approved or disapproved by the Project.

A detailed discussion of the life cycle steps is given in section 5.4 and its subsections.

5.3 MANAGEMENT APPROACH

The Project's approach to managing the development of Project software is, in priority order, based upon ensuring:

(a) that critical functional, performance and quality requirements are satisfied,

(b) that effective use of development resources is maximized, and

(c) that delivery schedules are met.

The responsibility of ensuring that the management objectives are met is assigned to the SSM, SAM, Spacecraft Managers, and IMs (see Section 4.3.3).

5.3.1 Software Management Responsibilities

Specific software management responsibilities are described below:

5 3.1 1 EOS CHEM SPACECRAFT SOFTWARE MANAGEMENT RESPONSIBILITIES

The SSM will take the lead in managing the spacecraft software elements. The SSM will develop the detailed management requirements for the provider and then assure that these requirements are met throughout the duration of the software life cycle. Other Project personnel (especially those in the Systems Office, Assurance Office, and OM) will participate in the development of the critical functional, performance, and quality requirements, and guide the implementation of these requirements. The SSM will be the award fee Event Monitor supporting the Spacecraft Manager who is ultimately responsible for the delivery of the software within budget and schedule.

5.3.1 2 INSTRUMENT SOFTWARE MANAGEMENT RESPONSIBILITIES.

The IMs will take the lead in managing the instrument software elements, with the assistance of the SSM.

5.3.1.3 GROUND SYSTEM SOFTWARE MANAGEMENT RESPONSIBILITIES.

For the Project, the Operations Manager (OM) will take the lead in monitoring the management of the Ground System software, with special emphasis on the Flight Operations portion of the ECS. The Spacecraft Manager, IMs, and SSM will assist the OM in the area of critical functional and performance requirements which affect the spacecraft.

5 3.1.4 SCIENCE TEAM SOFTWARE MANAGEMENT RESPONSIBILITIES

Science team software is developed under agreements with Principal Investigators and science team leaders. The IMs will be responsible for the science software budget. The SSM, in conjunction with the ESDIS Science Software Manager, will be responsible for the technical management of the science software development. The ESDIS Science Software Manager is delegated technical management responsibiliy for the interfaces between the science software and the DAAC.

The ESDIS Science Software Manager's role shall include, but not be limited to, the following:

(a) Review and approve science software management plan provided by the science teams.

(b) Support the IM with change requests with science software or Science Computing Facility (SCF) implications, through generation, review, revision, comment, and the CSFP boarding process.

(c) Provide information as needed to the IM in support of project reports, status summaries, and reviews.

(d) Support the IM through participation at instrument team reviews.

(e) Support the IM through review of instrument team technical documentation describing science software design and implementations.

(f) Resolving instrument team issues between the science software and the DAAC, and between the SCF and the DAAC.

5.3.2 Categorization and Classification Policy

It is the Project's policy that development of software shall be carried out using management, engineering, and assurance practices that are appropriate to the level of cost and risk inherent to development and use of the software, and its potential impact upon the system and the Project if the software fails to fulfill its requirements.

Based on the Project's policy and the software risk categories defined below, providers will describe within their SMP a process for determination of the risk categories of software to be developed and the management, engineering and assurance practices to be associated with each category.

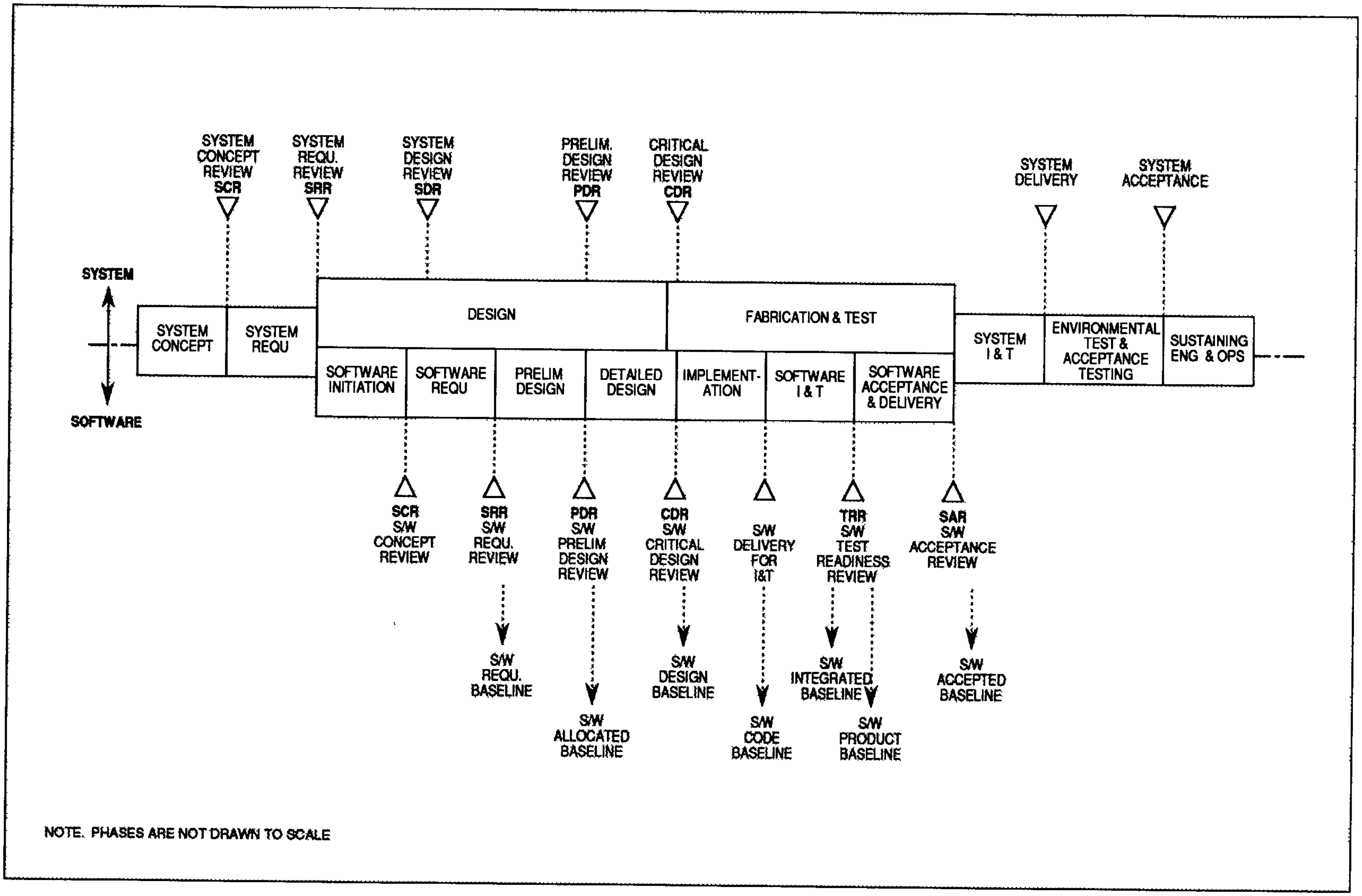

Figure 5.2.2-1 Typical NASA Software Acquisition Life Cycle

5 3 2.1 SOFTWARE CATEGORIES

The following software risk categories have been established by GMI 2410.7 [ref. 2.2-4]:

Category A - Critical Software - Software categorized as "Critical" is required to be highly reliable and of high quality. It will have to meet rigorous operational scenarios, and the consequences of failure are high. Full application of state-of-the practice software management, engineering, and assurance techniques are required to assure the software will fulfill its assigned role. Examples are flight software on a Class A or B NASA mission, and software that protects and operates major GSFC institutional assets. EOS CHEM is considered a Class B mission.

Category B - Important Software - Software categorized as "Important" is required to be above normal in reliability and quality. It is a key part of a system the failure of which could cause the loss of a difficult to replace asset or allow unauthorized access to data covered by the privacy act. Use of formal, high level software management, engineering, and assurance practices are required to meet the reliability and quality needs for the software. Examples are flight software on a Class C or D NASA mission, and command management software.

Category C - Normal Software - Software categorized as "Normal" is expected to operate reliably. Occasional failures can be tolerated, and failure of the software system cannot cause loss of a NASA asset. Adequate methods are to be in place to detect failures of the software and the effects of such failures and to compensate for them. Formality and organization are expected in the management, engineering and assurance processes used to develop the software, but extensive efforts are not to be applied to increase the reliability of the system. Examples are flight project integration and test software, and most science data processing systems.

Category D - Limited Use Software - Software categorized as "Limited Use" is generally personal in nature. It is acceptable if it fails rather frequently, and other qualities, such as ease of change, may be more important than reliability. Conservation of resources during development is determined to be more important than assuring quality and reliability, and there is a correspondingly low level of formality in the use of management, engineering, and assurance practices. Examples are science analysis software, and one-time engineering analysis support tools.

The Project will also develop a software criticality classification strategy for Launch Readiness. These criticality categories will provide guidance as to whether the software is required to be defect free in order to launch, and whether successful operation of the software is required immediately after launch. The two categories of "Critical" and "Non-critical" are sufficient for this purpose. This classification helps to correctly focus the all-important resources of time and money, and determine whether the software is "Go for launch".

Table 5.3.2.1-1 provides guidance as to software development and validation methodologies, along with those of launch readiness which should be used with each of the Elements. The launch readiness criticality classifications for each of the software Elements are still in a preliminary state with a final state determination by the spacecraft and instrument Preliminary Design Review (PDR) time frame.

SOFTWARE ELEMENT	SECTION 3 REFERENCE	GMI 2410.7 RISK CATEGORY	LAUNCH CRITICALITY
S/C FSW	3.1 1	A	CRITICAL
SGSE	3 1.2	B	NON-CRITICAL
SSDV S/C MODELS	3 1 3	A	CRITICAL
SSDV REMAINING COMPONENTS	3 1 3	C	NON-CRITICAL
INSTR. FSW	3 2 1	A	NON-CRITICAL*
IGSE	3 2.2	B	NON-CRITICAL
ISDV	3 2 3	C	NON-CRITICAL
MISSION OPERATIONS	3 3 1.1 1	A	CRITICAL
SPACECRAFT OPERATIONS	3.3 1.1.2	A	CRITICAL
INSTRUMENT OPERATIONS	3.3.1 1 3	B	NON-CRITICAL
SPACECRAFT SIMULATOR	3.3.1.1.4	B	NON-CRITICAL
DATA PROCESSING	3.3 1.2	C	NON-CRITICAL
GROUND SYSTEMS MGMT	3.3.1 3	C	NON-CRITICAL
COMMUNICATIONS (EDOS/ECOM)	3.3 2	A	CRITICAL
SCIENCE TEAM	3 4	C	NON-CRITICAL

* Exception: Instrument flight software in unmodifiable PROMs will almost always be classified as CRITICAL

Table 5.3.2.1-1 Software Risk and Criticality by Element

5.3 2 2 APPLICATION OF SOFTWARE CATEGORIES

The Project will assure that each provider is complying with the categorization and classification requirements imposed on them via the appropriate contractual document (SMRD, Instruments' PAR, Spacecraft PAR). The Project will use the resulting provider products during the software life cycle phases to assure an appropriate management approach for each category of software. The Project will pursue a more pro-active approach with the Category A software for which it has responsibility; specifically, the spacecraft Flight Element and the spacecraft models portion of the SDV Element. However, the instrument Flight Element will be an exception to the Category A software approach described below. The smaller budgets and corresponding fewer lines of code for instrument software necessitate that fewer requirements be levied on the instrument software provider in the way of independent testing, reviews, and assurance practices. The level of Project oversight will not be decreased, however. As detailed throughout this document, the SSM will support the various IMs with regard to all instrument software and will focus on the design, implementation, and testing of the instrument flight software to the extent possible.

For the Mission Operations, Spacecraft Operations, and Communications Category A Elements, the proper level of oversight will be determined by the ESDIS Project which has responsibility for these Elements. The Project will assist the ESDIS Project when reviewing related material for any of these Elements.

The Project's more pro-active approach with Category A software for which it is responsible will include assuring that the providers' efforts include requirements tracing, detailed verification and validation, reviews by the providers' systems personnel with regard to the completeness and thoroughness of the development effort, more peer design reviews and code walk-throughs, independence of the test team, and adequacy and completeness of the test approach, test plan, test procedures and analysis of test results. The Project will follow these efforts of the provider and the SSM will also provide closer scrutiny of the outputs and deliverables associated with this category of software. The SSM will be supported by both the SAM and CMO in this effort as they will focus more effort in their particular roles with Category A Elements. In addition, the FSSB will provide an IV&V effort targeting the operational aspects of the spacecraft flight software, GSE database and procedures, and the models portion of the SDV software.

Prior to PDR, providers will define the CSCIs that comprise each software Element, and assign a Category (section 5.3.2.1) to each CSCI. If the CSCI's category is lower or higher than that of the Element, the reason shall be justified in the provider's SMP or Software Development Plan. Following PDR, providers shall categorize each lower level component of the design architecture. In this process, the lower level components shall be assigned the same category as that of the CSCI.

5.3.3 Management Mechanisms

The following paragraphs identify the mechanisms that the Project will use to monitor and manage the providers' software life cycle development activities.

5 3 3 1 REQUIREMENTS DEVELOPMENT AND CONTROL

First level system software requirements for the CHEM spacecraft are defined in the EOS Common spacecraft Statement of Work [ref. 2.4-5], and the EOS Common spacecraft Specification [ref. 2.4-4]. First level system software requirements for the CHEM instruments are defined in the General Interface Requirements Document for EOS Common spacecraft/Instruments [ref. 2.4-3].

The providers will derive lower level requirements from the requirements in the above documents using the processes identified in section 5.4.3. and section 5.4.4.

The Project CCB and providers' CCBs are responsible for controlling software requirements that have been established as baselines at their respective levels. The control processes for the Project will be in conformance with the CM requirements in Section 10 of this document. The control processes for the providers will be in conformance with the CM requirements in the appropriate PAR.

Detailed requirements for each CSCI will be documented according to NASA-DID-P200.

5 3.3 2 SCHEDULE DEVELOPMENT AND CONTROL

See section 4.3.1 for schedule development and control processes.

5.3.3.3 RESOURCE DEVELOPMENT AND CONTROL

See section 4.1 for resource development and control processes.

5.3.3.4 INTERNAL REVIEW CONCEPTS

The SSM will use the services of Codes 302 and 303 with regard to assurance issues surrounding the software management of the Project. Personnel from these Codes will assist with audits, and reviews of plans and other documentation.

The SSM will also use the support of Code 700 to support the technical review and direction of the software development process. Their experience in these fields will be used in responding to technical issues and in panel membership at technical project reviews.

The SSM will also use the services of the FSSB, Code 512. Personnel from this Code will be involved with the IV&V of the flight software elements and will ultimately take over the long term sustaining engineering of the spacecraft Flight and SDV software for the CSFP missions. This staff will also be available for consultation both from a technical and management point of view.

5 3.3.5 EXTERNAL REVIEW CONCEPTS

The external reviews for the EOS CHEM spacecraft software provider are defined in section 10.2.5 of the spacecraft PAR. Reviews for the various instrument, ground and science team software providers are contained in their individual contract documentation.

5.3.3.6 BOARD SUPPORT

The Project has established a CCB which will address software issues. Its functions and roles are as defined in Section 10.

5.3 3 7 MANAGEMENT AND CONTROL

Control of costs and schedules, and assessment of progress are explained in Section 4. Risk management processes to be followed are in Section 9. Configuration Management is in Section 10.

5.3 3.8 METRICS

The Project will use metrics as management and quality indicators. To support this use, each provider will establish and implement a software metrics program which will enhance their capabilities to manage and direct the software development process and facilitate the growth of product quality.

Software metric data will be collected that support the quantitative evaluation and analysis of trends for the entire life cycle development process and the products that it generates. Metrics to be collected may include, but are not limited to:

- Number of requirements established/modified/deleted
- Source lines of code estimates and actuals
- Number of units completed
- Percent memory, CPU, and I/O utilization
- Detected code error rates
- Problem Reports and Change Requests opened/closed/remaining-open/cumulative
- Effort data (staffing profile)
- Number of audits, inspections, reviews, walk-throughs, etc.

The collection, reporting and analysis of metrics will be automated to the fullest extent practicable and will be performed on a monthly basis.

Metrics will be provided to the Project both as raw data and in graphical form.

Refer to Section 4.1.3.1 for additional detail on reporting of metrics.

5.3.4 Documentation Requirements

The Project will define the detailed documentation requirements that will be imposed on the providers in their individual CDRLs (in the case of science software, the documentation requirements are supplied by ESDIS). At a high level, the SMRD [ref. 2.4-2] requires the spacecraft contractor to comply with the documentation requirements of NASA-STD-2100-91 [ref. 2.2-7]. Instrument software providers are also required to comply with [ref. 2.2-7] by the CSFP ISMRD [ref. 2.4-7].

5.3.5 Risk Management

See Section 9 of this document for the Project's Risk Management Plan and approach.

5.3.6 Configuration Management

See Section 10 of this document for the Project's Configuration Management Plan and approach.

5.3.7 System Assurance and Integration

See Section 8 of this document for the Project's Assurance Plan and approach.

5.3.8 Deviation and Waiver Procedures

The Project will review all provider requests for deviations and/or waivers to software standards and requirements. Waiver requests will be submitted in writing to the Project, explaining the circumstances for the request and the justification for it. The waiver request will be submitted and approved before the provider takes any action based on the waiver. The Project will review the waiver and advise the provider of its assessments of the risks contained in granting the waiver. Waivers may only be granted by approval of the COTR.

5.3.9 Maintenance Of Management Plan

The Project SSM will review and revise this document as needed.

The provider's SMP will be maintained to be current throughout the software life cycle by incorporating those changes resulting from milestone reviews and risk abatement decisions. Revisions to the provider SMP are to be presented during the Software Management Review session of the next formal review that follows the revision.

5.4 TECHNICAL APPROACH

This section describes the systems engineering work to be carried out by the SSM during the various life-cycle phases of the software Elements, utilizing required provider deliverables and participation with other Project and GSFC entities. The focus of this section is on the spacecraft software. However, the SSM will assist the IMs by applying these same technical approaches to the instrument and science software to the extent deemed appropriate.

5.4.1 System Requirements and Constraints

System level requirements and constraints for the EOS common spacecraft aspect of the project are described in a number of documents. For the spacecraft subset, the documents include the Software Management Requirements Document, the Statement of Work, the EOS Common Spacecraft Specification, the General Interface Requirements Document, the OASIS Guidelines, the PAR, and the CDRL. These documents are the baseline from which the provider shall propose their approach and begin their development process. The Project SSM will take a very pro-active role in the management of all life-cycle aspects of the three software Elements composing the spacecraft portion. These three Elements are the Flight Software, the GSE Software, and the SDV Software. Each of these Elements, though intertwined in relationship with each other, has its own life-cycle phases which are individually different in scope, content, and duration.

5.4.2 Concept Definition Process

The Concept Definition phase begins with the Phase B effort and proposal submission of the provider. That effort will be reviewed by the SSM as the starting technical reference point for the development of the spacecraft software.

During this phase the SSM will work closely with the provider's SSM to establish and promote a good working relationship. The development of this relationship is key to the development of good communication between the two SSMs. This assists in the flow of ideas, discussion, and solution to problems that will be faced throughout the project life-cycle.

In addition to the Concept document which was delivered in its draft version with the proposal and which will be delivered in its final version near the completion of this phase, there are two other key management and technical documents that are due from the provider during this phase. They are the draft versions of both the Software Development Activities Plan and the Software Requirements document for both the Flight and SDV Elements. As both of these documents require NASA approval Action A, as defined in the CDRL, the SSM will ensure that the review of these key documents and any resulting comments will be completed and forwarded to the provider within 30 days.

From a management perspective the SSM will review the Software Development Activities Plan for both the Flight and SDV Elements with respect to the detail planning and understanding of the many aspects of the software effort involved with the development of each Element. The technical management of required resources, schedule planning to the lower levels of software components, delivery schedule, software conventions, personnel skills, software build approach, etc. will be analyzed. Concerns, questions and comments will be written and discussed with the provider SSM such that a complete and thoroughly understood final version of this working document can be completed during the Requirements life-cycle phase.

The draft Requirements document will be reviewed based on completeness and thoroughness of the providers' efforts. The SSM will ensure that a traceability matrix is developed and reviewed to ensure a complete mapping of the provider's derived requirements to those of the Project. As this document is the basis for all follow-on design, test, and IV&V efforts, the SSM will ensure that the review of this document is thorough and complete.

Independent of the work with the provider during this phase, the SSM will establish a working relationship with the other applicable organizational entities involved with the Project. This will include QA personnel from Code 300 and the Code 500 OM. This may also include membership on various Working Groups, Operations Panels, etc. in order to fully comprehend the needs of these entities with regard to the common spacecraft, and to promote and/or defend aspects of the common spacecraft approach. One such group is the OASIS Working Group. Participation in this group will provide the SSM with valuable data on the use of OASIS in the EOS AM and PM Projects. The SSM will provide any necessary material or requests from these groups to the spacecraft and instrument providers. The SSM may request participation by the providers in certain of these groups.

The SSM will serve as co-chairperson at the Software Concept Review (SWCR). Note that there is no Concept Review currently scheduled for the GSE Element. For the other two Elements, this review will be based on the final of each Element's Concept Document which will be delivered prior to the review along with the Development Plan and Requirements Documents. The SSM will ensure that part of this review includes the findings of the providers' Verification and Validation (V&V) staff. The SSM will also extend an invitation to the FSSB personnel who will perform IV&V on the Flight Software Element to attend the SWCR. The FSSB IV&V team will not formally begin their work until later in the development life-cycle yet the SM will ensure that all technical material delivered and presented during this phase is made available to the FSSB IV&V team. The SSM will review the Lessons Learned Report emanating from this phase and make the material available to other Project personnel. The Software Review Reports delivered after completion of the SWCR will be monitored by the SSM as these contain any Review Item Discrepancies (RIDs) and related follow-on action. The status of the RIDs will also be followed by the SSM through the Monthly Progress Report. Systems personnel and other Project personnel will review the software from an EOS CHEM mission point of view at the System Concept Review (SCR).

5.4.3 Software Requirements Definition Process

The starting point for this phase is the successful completion of the Concept phase, including delivery of the final of the Concept document for each Element and the draft version of the software requirements for the Flight and SDV software Elements. During this phase of the life-cycle these two Elements' software requirements will be refined and updated to include completion of the interface requirements. In addition, the software requirements for the GSE, and a draft Test Plan for each of the Elements will be developed by the provider.

The Project will ensure that all work is completed on schedule and is technically thorough, complete, and meets all standards for documentation and reporting as defined in the DIDs of the CDRL. Metrics will be used as an aid in the monitoring of work. Refer to section 5.3.3.8 for additional information on metrics.

The SSM will work with the provider and other internal and external Project organizations to develop and refine the interface requirements. The SSM's role in this process will include ensuring that the appropriate GSFC organizations provide the necessary resources and assistance in order to define the scope and content of the requirements. The SSM will, at his discretion, attend any or all of the interface meetings with the provider.

The SSM will review the final requirements documents for all Elements for completeness, traceability, and understanding before approval of this aspect of the provider's work. Prior to this review the SSM will need assurance that all requirements have previously been reviewed and accepted by the provider's V&V staff, systems engineering staff, QA staff, and test personnel. All Flight Element requirements will also be forwarded to the FSSB at GSFC who will be performing the IV&V for the project.

The SSM will monitor and review the provider's traceability approach to ensure adequate controls and flexibility. It is expected that the provider will provide an automated tool to assist with the traceability function and that the SSM will have access to this capability.

Based on contractual requirements, the provider may not be granted permission to continue with work associated with the software requirements for either the spacecraft Flight or SDV Elements until the requirements documents are approved. The SSM will ensure that the review of these key documents and any resulting comments will be completed and forwarded to the provider within 30 days of delivery.

For the GSE Element, the requirements and preliminary design phase will be combined. There is no draft version of the GSE software requirements. Final software requirements for the GSE Element are due to the SSM by the end of these combined phases. The SSM will again review the scope, traceability, completeness, and understanding of these requirements. Unlike the other two Elements, the contractor will be able to continue with work associated with this Element while the SSM is reviewing the GSE software requirements.

As part of the requirements phase, test planning will begin. This will include a general method for verifying requirements identified and included in a draft Test Plan that is a deliverable due from the provider during this phase. A general method of testing will be identified for each numbered requirement.

In evaluating the approach and content of this draft version of the Test Plan, the SSM will use the services of other technical resources. As this Test Plan must dovetail with the Project Test Plan, the Project's I&T Manager will be consulted with regard to approach and content. The SSM will use the findings of the provider's V&V organization in reviewing this work. This document will also be forwarded to the GSFC IV&V organization for their review.

As the requirements analysis is done, the SSM will ensure that all identified technical risks are handled as defined in section 9.

The requirements are reviewed in the phase ending Software Requirements Review (SWRR). A software requirements baseline will be established by the provider after the satisfactory resolution of all RIDs. The RIDs will be defined in the Software Review report due after the completion of the SWRR, at which the SSM will serve as co-chairperson. The contents of the software requirements baselne become a permanent part of all succeeding baselines and are the basis against which the remaining development effort is validated.

5.4.4 Software Design and Implementation Process

The software design and implementation process involves completing the software preliminary design, the software detailed design, the coding and unit testing, and the integration of all software modules. The process is to be done in four phases, each of which is described below.

5 4.4.1 SOFTWARE ARCHITECTURAL DESIGN PHASE

The objective of the software architectural design phase is to verify that the provider has developed an overall design for the software, allocating all of the requirements for each of the Elements to software components. At this point the software requirements are controlled and managed so that the contents of the requirements baseline are changed only by a formal CM process. The phase ends with the Software Preliminary Design Review (SWPDR), during which the SSM and provider agree on the architecture of the system that will be produced. The SSM will serve as co-chairperson for this review. Rework and action items resulting from the reviews are tracked and completed. These items will be tracked through the Review reports prepared by the provider upon completion of each review. The action items will also be tracked on a monthly basis via the Monthly Progress reports until each item is complete.

During this phase the SSM will be involved with the provider in periodic briefings concerning the decomposition of software for each of the Elements. The SSM will use early working copies of design material, Monthly Status Reports, and metrics to follow the decomposition process. Beginning with this phase, spacecraft software metrics will be reported at the CSC level.

To support the integration and testing aspect of the program, the SSM will ensure that if multiple flight processors are used, that the allocation of CSCIs does not cross hardware processor boundaries. The purpose of this is to ensure that complete software builds can be independently tested.

For the SDV Element, the SSM will be involved in the early design of both the SDV software and hardware components to ensure that the design is on schedule and provides the adequate tools and dynamic simulator facilities to develop and test the flight software. This Element will not only be utilized by the provider but copies of the spacecraft SDV facility, both hardware and software, will be used in the EOC at GSFC and by the FSSB IV&V team. The design and development of this Element must meet not only the provider's schedule and needs, but also those of the EOC and FSSB IV&V .

For the GSE Element, this phase has been combined with the Concept and Requirements phases. A primary reason for the alteration of the life-cycle for this Element is the extensive use and maturity of existing software tools and software reuse that is anticipated. Project personnel will undertake their own learning process with one aspect of this Element, OASIS, to assist in the understanding of the scope of this tool's capabilities with regard to I&T of the software. Project personnel will have access to multiple computer platforms and copies of OASIS to prototype and demonstrate the capabilities and interfaces required with the spacecraft and instrument design. Any relevant lessons learned, or applications developed, will be shared with the providers.

For all proposed COTS software to be used in conjunction with any of the Elements, the SSM will closely monitor the details of such use. It is imperative that before the design progresses, that projected use of any COTS software be examined closely. The SSM or IM will need assurance with any such software proposed by the provider, that all licenses and copyrights are available to the government for its use. For COTS software integral to any "critical" software components of the Elements, the SSM will ensure that the provider has procured the source code to such software for the current and any future releases. The SSM will also monitor any proposed modifications to such COTS software for test considerations. Assurance requirements in the PAR for the EOS Common spacecraft [ref. 2.2-12] state that if 20% of any COTS software lines of code change then a more rigorous test approach will be adopted.

A Preliminary Design Document will be developed by the provider for each Element during this phase. This document is published in its preliminary state as it will be further enhanced during the Detailed Design phase. The SSM and IMs with support from the SAM, and IV&V staff, will ensure that these documents follow the standards as defined in the CDRL DIDs and contain the information required to support the development of each of the Elements. Any comments, concerns, or modifications required of the documents will be furnished to the contractor.

For each Element, the provider is to prepare a draft version of a User's Guide or, in the case of the SDV Element, a User's Manual. These documents are to be delivered in a preliminary state during this phase. For the SDV Element, the document is to describe the use of the entire SDVF to include both hardware and software. The SSM, with support from the FSSB IV&V team and EOC personnel, will review these documents for content and ease of use. The goal at this point is to develop a guide/manual that will support the long term use and maintenance of these Elements by personnel other than the provider.

5.4 4.2 SOFTWARE DETAILED DESIGN

During the software detailed design phase, the architectural design is expanded to the CSU level. The resulting detailed design defines the design of each CSCI for each Element in a way that will provide all the required capabilities and meet the design constraints specified in the software allocated baseline. Software specifications include designs at a level and in a form such that unit design, coding, and testing can be performed. This specification identifies the modules that make up the CSCI, the architecture of each module to the unit level, the module and unit interfaces, the data files to be used during the execution of the CSCI, and the user interface to be implemented in the CSCI. The detailed design will be added to the design documentation set started during the Architectural design phase.

During this phase the SSM and IMs will monitor monthly status reports and metrics for details on development. Beginning with this phase, metric reporting for the spacecraft will be at the CSU level and continue at this level through the remaining life-cycle phases.

The SSM will attend design peer reviews, at his discretion, for any Element. The SSM will monitor the final design of the SDV Facility and the acquisition of the software tools for use with each of the three dynamic simulator facilities. By the completion of the flight Detailed Design phase, a development system for flight software will need to be in place and operating in order for flight code development to stay on schedule.

For the flight software, the SSM will monitor the algorithm approach and development for various spacecraft components. GSE data base development and population will be reviewed. The SSM will utilize systems engineering, operations, and assurance support from the Project and other divisions within GSFC in support of this effort. The goal is to ensure that the provider is following a path of development that is consistent with prior experience in these areas. Working Groups and technical forums may be utilized to support this analysis.

The final version of the Test Plan is due for each Element by the end of this life-cycle phase. The SSM and IMs, in conjunction with QA and the Project's I&T Manager will assess the thoroughness and completeness of these Plans. The Plans will incorporate not only spacecraft testing but also integration testing with the instruments and the incorporation of data bases and procedures developed by the instrument providers. The SSM will ensure that the provider has performed a detailed analysis of how these procedures and data bases will be incorporated into spacecraft level testing. In addition to the Test Plan for each Element, the SSM, IMs, and test personnel will review the preliminary version of the Test Procedures Document for each Element.

For the spacecraft Flight Element, the provider will provide two additional documents during this phase. The first is a current version of the User's Guide developed during the previous phase. The SSM will review this document to see how comments, concerns, and additional data have been incorporated into this document since the preliminary version. The second document is a Firmware Support manual that will document in detail all firmware that will be included as part of the Flight Element. This information will be analyzed by the Project and IV&V personnel as it is a crucial document for maintenance and testing of firmware.

This phase will culminate in the Software Critical Design Review (SWCDR) for each of the Elements, with the SSM serving as co-chairperson for the spacecraft Elements.

5.4.4.3 SOFTWARE IMPLEMENTATION

During the software implementation phase, the software is coded and unit tested. All documentation is produced in quasi-final form, including internal code documentation. At the end of the phase, all required products shall be ready for delivery, subject to modification during integration and testing.

During this phase of the life-cycle the SSM will review the schedule and the progress of all Elements. Acquisition and testing of hardware and simulator development will be reviewed. The SSM will stay in close contact with the spacecraft provider's SSM, the IMs, and the instrument providers' SSM during this period. A concerted effort will be made to attend either in person or by electronic means (e.g. teleconferences, video conferences) the numerous technical briefings and code walk-throughs held during this phase. The SSM will utilize the QA personnel to audit the development process and documentation throughout this period. This documentation will include the Software Development Folders (SDF).

The SSM will work with the GSFC IV&V organization to ensure that they are cognizant of the provider's efforts and are prepared to receive hardware and software from the provider and to handle their testing responsibilities.

The SSM will monitor the work of the provider's software development team during this period through metric reporting and progress reports.

At the end of this phase, the Code Baseline is struck. This is the first time that the code itself becomes part of a configuration management baseline. This baseline will be a provider baseline, without acceptance review of products by the Project.

5 4.4 4 SOFTWARE INTEGRATION AND TEST PHASE

The objectives of the software integration and test phase are to integrate the software units into a completed system, discover and correct any nonconformances, and prepare for the formal acceptance of the system. The phase ending review is the Software Test Readiness Review, during which the developer provides to the Project evidence that the software system is ready for acceptance testing. During this phase, the test plan is executed, the software product documentation is updated and completed, and the products are finalized for delivery.

This phase can begin as code baselines are completed by the development team. The SSM will examine the provider's Software Development Plan for early assembly of code into CSCIs such that testing can begin as early as possible. Early baseline CSCIs may contain stubs and drivers developed by either the test or development team to facilitate testing. From the Test Plan and SMP, the SSM will verify that code under test above the CSU level is being subjected to testing from a test team independent of the developers.

As code for each of the Elements is completed and baseline builds completed, the SSM will ensure that tested and delivered code is entered into the CM process. The SSM will also ensure that the GSFC IV&V Team will be prepared to accept early deliveries of baselined software such that it can be used in their independent testing.

The SSM will take responsibility for ensuring that a process is in place for the reporting of problems, and that errors found by the IV&V Team are tracked through the NRCA system (refer to section 8.7). As errors are found through the provider's testing or via IV&V, regression testing takes place for corrected code. The SSM will, with the assistance of QA, monitor the metrics and progress reports produced by the test program.

After the system testing has been completed and put under formal control, QA will perform audits to verify that the actual performance of each CSCI complies with the requirements stated in the baselined software requirements document. This is accomplished by evaluation of the test methods, procedures, reports, and other engineering and design documentation. An audit is also performed to ensure that all deliverable items are present and complete, and the system is ready for acceptance testing.

After the provider certifies that the audits are complete, the provider will conduct a Software Test Readiness Review (SWTRR). After resolution of any problems found during the SWTRR, the software integrated baseline is struck. This baseline contains the deliverable software and documents, to include Element Test procedures, Users' Guide/Manual, preliminary Version Description documents, and the Software Integration Test reports. Along with the software, all other deliverable items such as populated data bases and tables, computer installation procedures, and test beds, are part of this baseline.

5.4.5 Software Acceptance Test and Delivery Process

During the software acceptance test and delivery phase, the formal acceptance test procedures are carried out. The SSM, IM if applicable, QA, and FSSB IV&V team will witness a requirements-driven demonstration of the software to show that it meets the baselined requirements. In addition, the Project will independently verify and validate some portions of the Flight Element software by way of operations and FSSB IV&V team participation in end-to-end testing. The intent of this testing to assure that the software will function correctly in its intended environment.

As part of this phase of the life-cycle, there are document deliverables for each of the Elements. For the Flight Element, the "as-built" design document is due. Version Description documents are due for each of the Elements. Before the Software Acceptance Review (SWAR), an Acceptance Test Report for each Element is due.

For the spacecraft SDV software, the testing and acceptance of both the facility hardware and software will take place in two phases. Initially, because the SDV software is required for Flight software development, there will be an acceptance testing for the SDV software-only version prior to beginning the Flight software Implementation phase. The second SDV acceptance test phase will take place and include both the SDV hardware and the SDV and GSE software. The GSE software acceptance test must occur before this second SDV acceptance review. Both the SDV hardware and software, along with the GSE software are required at the time of Flight software integration and test. The SSM will monitor the progress of this schedule and ensure that validated hardware and software are available for the Flight Element acceptance testing.

Upon final delivery of the above documents, and the end of the testing and any re-testing required by non-conformances for each Element, the provider will conduct a Software Acceptance Review (SWAR). The review(s) will consider the test results and the outcome of audits performed by QA. After resolution of issues identified at the review, the software products for that Element will be accepted for use in spacecraft level testing.

Early in this life-cycle phase the SSM will establish with the provider training classes for the GSFC EOC Team and the GSFC IV&V Team in the use of the dynamic simulator facilities, software, and GSE software. The scope of this training will be defined in the provider's SMP. In addition, the SSM will ensure that a provider software maintenance process is established for any Command and Data Handling or Flight Software Testbed equipment located at the dynamic simulator facilities used by both the EOC and FSSB IV&V teams.

5.4.6 Software Maintenance and Updating Process

After the SWAR, the software is approved for use with the flight hardware during spacecraft I&T. It is anticipated that some software changes will be required during this testing due to discoveries about the hardware or software that were not visible on the SDV facility. Additional IV&V by the GSFC Team may also uncover hidden faults in the software that must be corrected. The same level of testing, V&V, QA, and CM monitoring that existed prior to the SWAR, will be applied by both the Project and the provider during the generation of additional software releases prior to spacecraft launch.

If changes are still being made to "Mission Critical" software six months before launch, they will be classified as Class I changes and must be approved by the Project. As the amount of test time available decreases, the risk of making changes increases, and the Level II (Project) CCB will take this into consideration when dispositioning the Configuration Change Request. The CCB must also decide the format of the software change since a "patch" to the software may be considered less of a risk than a total re-compilation and release.

Software activities and maintenance during spacecraft launch, early-orbit checkout, and routine operations are discussed in section 7, Sustaining Engineering and Operations Activities Plan.

5.4.7 Software System Engineering

The following sections address aspects of software engineering methodology to be used by the providers and monitored by the SSM. These sections do not place requirements on the providers. Software engineering requirements on the providers can be found in the parallel sections of the SMRD.

5 4 7.1 IMPLEMENTATION POLICIES AND STANDARDS

The following policies and standards apply to all software Providers and all software developed by them. Specific standards to be followed are listed in section 2.2, Applicable Documents.

5.4.7 1.1 Software Development Methods

Within the provider's SMP, the process for performing requirements analysis, design, coding, integration, and testing of the software will be defined. For the spacecraft software provider and instrument software providers, the development process may follow the NASA Software Acquisition Life Cycle, version 4.3. This life-cycle is closely synchronized with that of the rest of the EOS common spacecraft program. One major tailoring of this spacecraft life-cycle process is with the GSE Element. For this Element, a number of the initial life-cycle phases have been combined. In lieu of a single SWAR for both the GSE and SDV Elements, a number of SWARs are expected to mesh with the overall schedule for delivering Flight software. The SSM and IMs will ensure through the QA process and via meetings and the review of documentation that this process is being followed.

The NASA Software Acquisition Life Cycle, version 4.3 development process is not mandated for the production of Science Team software. The approach to be used by the various science teams for software development will be defined in their individual SMPs.

5.4 7.1 2 Software Engineering Environment

The SDV Element in conjunction with the GSE OASIS system and any other test support environment as proposed by the provider will be the software engineering (development) environment used to support the software engineering effort for Flight Software and testing. As these are both Elements of the contract, the provider will, through the use of CDRL deliverables, define this environment, test the environment, and maintain the hardware and software according to contractual terms.

The provider may also, as part of the overall engineering environment, be contractually required to provide all technical documentation in electronic form with or in lieu of the paper product. The forum for this transfer will be in accordance with the tools and requirements as set forth by the Project.

5 4.7.1.3 Top-Down Software Design

The decomposition of developed software will follow that standard defined in MIL-STD-2167A, section 4.2. For each Element, the design will be initiated by establishing a functional design hierarchy, in which the top levels will be handled as CSCIs. The SSM will ensure that this level of processing does not cross hardware processor boundaries in order to better support testing. The SSM will ensure that the decomposition flows to the use of CSCs and to the lowest component CSUs. This decomposition will also support the process of software reuse beginning at the lowest level of code.

5.4.7.1.4 Non-Developmental Software

The Project supports the use of Commercial Off-The-Shelf (COTS) software by the providers to promote cost effectiveness. But its use requires safeguards. These concern the use of COTS software in "critical" software and in the need for adequate testing. For "critical" software, the provider shall ensure that the source code is provided for the COTS product and any upgrades purchased or received. Also, the provider will be encouraged to obtain an agreement with the COTS vendor ensuring that the vendor will continue to maintain older "frozen" versions of the software. The provider is responsible for a more rigorous test approach for "critical" COTS software as it is not subject to test scrutiny throughout the development life-cycle. The SSM will ensure along with QA that all non-conformance reporting and CM processes apply to all COTS software. Also, QA will ensure that if changes to COTS software exceed 20% of the lines of code that all QA provisions as stated in the PAR are performed.

The OASIS system from the University of Colorado, which may be used in conjunction with I&T, provides the required format for the interface between the EOS CHEM spacecraft GSE and the various instruments' GSE. The SSM will ensure that the spacecraft builder and instrument builders reach early agreement on the practices, standards and conventions to be used in the development of OASIS databases and CSTOL building blocks for spacecraft integration and test.

5 4.7 1.5 Computer Software Organization

The Project has defined the three Elements that will comprise the software systems of the spacecraft and instruments. It has been left to the providers to determine the decomposition of these Elements and their organization to the lowest level CSU components. This decomposition will be reviewed by the SSM and IMs through design documentation and reviews. The SSM will look for a decomposition scheme that allows for reuse of software components and assures that testing can be handled in an efficient manner.

5.4.7 1.6 Traceability of Requirements to Design

The SSM will ensure that traceability is performed throughout the entire development process. It is included within each life-cycle phase and is part of the documentation requirements. It is a goal of the SSM that traceability work performed by the provider will use a Computer Aided Software Engineering (CASE) tool and is made accessible to the Project on an on-going basis via electronic means.

Traceability begins with the requirements phase of each Element and ends with the traceability of test cases and procedures back to the design and requirements. The process for performing this function will be defined in provider's SMP.

5.4.7.1 7 High Order Language

The SSM will ensure that the software implementation is done using a High Order Language (HOL) as defined in the appropriate Specification document. If the provider is proposing a change in the use of a high level language to one that is not listed or to the use of a lower order language, the Project will require a waiver be submitted and approved before such action is allowed to occur.

5.4.7 1 8 Design and Coding Standards

The SSM, through the QA function, will ensure that standards defined and approved in the provider's SMP are followed for the design and coding of all Elements.

5.4.7.1.9 Software Development Folders

By way of requirements established in the SMRD, the spacecraft provider will develop, maintain, and make accessible to the SSM and QA the SDFs or UDFs. It is the desire of the SSM that these SDFs/UDFs be made available on an as needed basis both in electronic and hard-copy format. QA audits will be performed to ensure that the SDFs have been created, maintained, and are complete for all Elements. Instrument software SDFs will be examined by the SSM and QA personnel at the request of the applicable IM.

5.4 7.1.10 Processing Resources and Resource Capacity

It is the responsibility of the spacecraft and instrument providers to analyze the processing resource requirements, such as computational use and timing, memory utilization, I/0 channel utilization (including bus utilization) for the Flight processors in particular and all processors in general. The SSM will monitor this aspect of the development through the plan for Flight Processor allocation in the SMP, and the allocation of processor resources among the CSCIs and CSCs as detailed in the various Elements' Software Development Plans. This information is also reported to the Project on a monthly basis through the Monthly Status report and metrics.

5.4.7.1.11 Maintainability

Software maintainability is defined as the ease of detecting and correcting errors in the software. The provider's plans for producing maintainable code will be included in their SMP. The necessity of producing maintainable code which will be transferred to another organization for operations, is discussed in section 7, Sustaining Engineering and Operations Activities Plan.

The spacecraft and instrument software providers' code will be evaluated by the SSM and IMs during the software life cycle reviews and walkthroughs for the ease with which changes can be made. Such issues as modularity and compiler procedures are important not only for the inheritor of the software, but for the developer as well, since troubleshooting and making new versions of the software consume much of the developer's time.

Responsibility for maintenance of the Science Team software will remain within the developing organization. Therefore, the IMs, OM, and SM will evaluate maintainability based only on its effect on the science development life cycle, cost and schedule.

5.4.7.2 INTERFACE CONTROL PROCESS

Interfaces external to the providers software will be documented in IRDs and ICDs. These IRDs and ICDs are included as part of the requirements or design documents, or can be independently rolled-out into separate documents. These documents, if rolled-out, will be placed under separate CM control as are all other documents for each Element. The Project will establish the requisite Interface Working Groups to support the provider in developing the various IRDs and ICDs. The provider will name a member of their team to the requisite working groups.

5.4.7.3 DATA GENERATION AND MANAGEMENT PROCESS

Development of default and baseline values for tables and parameters used in conjunction with the GSE and Flight software to control the test operations or computations of the spacecraft software, is the responsibility of the spacecraft contractor, except where the parameters are, in effect, an interface to an instrument or non-spacecraft system or component. In this case, the selection of the parameters and development of their values is the responsibility of the instrument provider or the IWG. Once selected and approved by the Project, the parameters and their values will be placed under CM control.

Generation of test data will be the responsibility of the contractors. The Project will ensure that the selection and availability of test data from the various providers of other system components is prepared and delivered to the spacecraft contractor in time for all testing. During the requirements analysis process, a preliminary test plan is to be developed (see Section 5.4.3). Each version of test plans shall show the source of data needed to execute the tests. The Project will use this information to plan for the availability of required data from all other interfaces.

5.4.7.4 PERFORMANCE ASSESSMENT PROCESS

The assessment of performance against performance requirements shall be done as part of the integration and acceptance testing described in sections 5.4.4.4 and 5.4.5, and generally referred to in section 8.2

5.4.7 5 OPERATIONS MAINTENANCE PROCESS

Sustaining engineering and operations are described in section 7.0 of this plan.

SECTION 6.0 - DEVELOPMENT ACTIVITIES PLAN

This section of the plan is omitted since the Project will not directly develop any software. Each provider will include a Development Activities Plan in the required Software Management Plan (see Section 1.2).

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SECTION 7.0 - SUSTAINING ENGINEERING AND OPERATIONS ACTIVITIES PLAN

The purpose of this Sustaining Engineering and Operations Activities Plan is to define the process by which the Project intends to maintain and operate the software, and process change requests. This includes plans for training the users and operators of the software. This section is structured according to software Element.

7.1 SPACECRAFT FLIGHT SOFTWARE

The early-orbit operations of the spacecraft software begin with the launch. Routine modifications of the software data tables and stored commands are the responsibility of the Flight Operations Team. Internal data and all code modifications are subject to the approval of the Project CCB, and are developed and validated by the provider, just as prior to launch. Emergency on-orbit modifications may be authorized by the CSFP Operations Manager if waiting to convene the Project CCB is not feasible.

Following early-orbit check-out, the responsibility for maintenance of the Flight software will be transferred to the GSFC FSSB. The same organization will be performing IV&V on the flight software utilizing the supporting GSE and SDV software and dynamic simulator facilities. FSSB will also be responsible for maintaining the GSE and SDV software and dynamic simulator facilities .The transfer of responsibility from the provider to the GSFC FSSB for the internal data and code modifications during normal operations is described in Section 11, Delivery and Operational Transition Plan.

Following the handover to FSSB, the Project's involvement in the maintenance of the flight software and the software CCB will decrease. The Project will continue to be available to support spacecraft emergency resolution during the life of the spacecraft.

7.2 SPACECRAFT GSE SOFTWARE

Sustaining engineering of the GSE software begins immediately following a successful SWAR. Since the purpose of the GSE is to accomplish spacecraft I&T, this element is covered in Section 5.4.6.

7.3 SPACECRAFT SDV SOFTWARE

Operations of the SDV software begin immediately following the successful SDV Element's software-only SWAR. Reference the SMRD, section 5.1.c for additional information concerning the SDV Element approach. Since the purpose of the SDV software is to accomplish the development and validation of the above two Elements, operations of this Element are also covered in section 5.4.6.

Between launch and the end of the early-orbit checkout, the responsibility for maintenance of the SDV software will remain with the spacecraft software provider. Changes to the "Mission Critical" models may be required based upon information learned about the spacecraft hardware in orbit. As with flight software, these changes must be approved by the Project CCB. The transfer of responsibility from the provider to the GSFC FSSB for the SDV software maintenance during normal operations is described in section 11, Delivery and Operational Transition Plan.

7.4 INSTRUMENT FLIGHT SOFTWARE

The respective Responsible Agency (reference Section 1) will be responsible for each instrument's flight software from delivery to spacecraft I&T through the initial on-orbit operation of the spacecraft. The instrument provider will work with the spacecraft contractor to install any required instrument flight software modifications during the pre-launch I&T phase. Modifications could take the form of PROM change-outs or spacecraft uplink commands to change the instrument microprocessor's RAM and/or Electrically Erasable Programmable Read-only Memory (EEPROM). Following launch, the representatives of the responsible Instrument Team will work with the Flight Operations Team to provide and assure the correct uplink of any instrument flight software modifications. The SSM will assist the IM in assuring that plans are in place for continuous sustaining engineering capability.

7.5 INSTRUMENT GSE SOFTWARE

The respective Responsible Agency will be responsible for each instrument's GSE software through the launch of the spacecraft. This includes the period when the instrument GSE is located at the spacecraft contractor's I&T facility, or at the launch site.

7.6 INSTRUMENT SDV SOFTWARE

The respective Responsible Agency will be responsible for each instrument's SDV software through the launch of the spacecraft. This includes the period when the instrument is located at the spacecraft contractor's I&T facilities, or integrated on the spacecraft at the launch site. If the instrument flight software contains complex algorithms, or is likely to require modifications based on a change in operational philosophy during the mission, the Responsible Agency must transfer the ability to develop and validate these changes to representatives of the applicable Science Team. The SSM will assist the IMs in assuring that plans are in place for a smooth transfer of the SDV hardware and software.

SECTION 8.0 - ASSURANCE PLAN

The Project will conduct a software assurance program that shall include quality assurance, verification and validation, quality engineering, safety assurance, and security and privacy assurance. The Project Software Assurance Manager (SAM) shall be responsible for planning and execution of the assurance program. The following paragraphs detail the Project's plan. Software assurance requirements for software providers are contained in Section 8 of the SMRD.

The Project will assure that each provider has instituted a software assurance program compliant with [ref. 2.2-4] and that the program is defined in either their SMP, the AMP or PAIP, or in a separate Software Assurance Plan.

8.1 QUALITY ASSURANCE PLANNING

The Project will conduct a program of Software Quality Assurance (SQA), which is a planned and systematic approach to the evaluation of the quality of and adherence to software product standards, processes, and procedures. SQA includes the process of assuring that standards and procedures are established and are followed throughout the software acquisition life cycle. Compliance with agreed-upon standards and procedures is evaluated through process monitoring, product evaluation, and audits. Software development and control processes shall include quality assurance approval points, where an SQA evaluation of the product shall be done in relation to applicable standards.

8.1.1 Approach and Activities

The Project will conduct oversight of the provider SQA organization to assure that the provider is carrying out a software assurance program that meets contractual requirements. The Project SAM will support the FAM in this oversight responsibility. The Project will perform both scheduled and unscheduled audits of providers to establish the degree of conformance to the standards, procedures and reported status.

The FAM and SAM will look for the spacecraft software provider to comply with the following:

(a) During the Software Concept Phase, SQA activities will include reviewing management and development plans to assure that the processes, procedures, and standards identified in the plans are appropriate, clear, specific, and are capable of being audited.

(b) During the Software Requirements Phase, SQA activities will assure that the software requirements are complete, testable, and properly expressed as functional, performance, and interface requirements.

(c) During the Software Architectural (Preliminary) Design Phase, SQA activities will:

- assure adherence to design standards,
- assure that all software requirements are allocated to software components,
- assure that a test verification matrix exists and is kept up to date,

- review Preliminary Design Review documentation and assure that all action items are resolved, and
- assure that the approved design is placed under configuration control.

(d) During the Software Detailed Design Phase, SQA activities will:

- assure that approved design standards are followed,
- assure that results of design inspections are included in the design, and
- review Critical Design Review documentation and assure that all action items are resolved.

(e) During the Software Implementation Phase, the SQA activities will audit:

- the status of all deliverable items,
- configuration management activities and the software development library, and
- the NRCA system.

(f) During the Software Integration and System Test Phase, SQA activities will:

- assure that test reports are complete and correct,
- assure that test non-conformances are reported and resolved,
- assure readiness for Acceptance testing, and
- participate in the Test Readiness Review and assure all action items are completed.

(g) During the Software Acceptance and Delivery Phase, SQA activities will:

- assure that the Acceptance Test report is complete and correct,
- assure that Acceptance Test non-conformances are reported and resolved,
- assure software readiness for spacecraft I&T (if applicable), and
- participate in the Acceptance Test Review and assure all action items are completed.

(h) During the Spacecraft I&T Phase, SQA activities will:

- assure that all software related problems are logged in the spacecraft NRCA system, as well as the software change system,
- assure traceability between the above two systems,
- assure that only Software CCB approved changes are made to the software, and
- assure that the same standards and procedures which were followed in the original development of the software are also followed for updates.

(i) During the Launch and early-orbit Checkout Phase, SQA activities will assure that the same standards and procedures which were followed in the pre-launch development of the software are also followed for the post-launch software updates.

8.1.2 Methods and Techniques

The FAM and SAM will use an audit guide and/or checklist, and the provider's project-approved standards to perform scheduled and unscheduled audits of the provider's software process, products, and status reports.

8.1.3 Products

The FAM and SAM will develop audit reports in accordance with Audit Report, NASA-DID-R002 for each audit conducted. The results of the audit will be conveyed to the provider so that appropriate action can be taken to correct any deficiencies found.

8.2 VERIFICATION AND VALIDATION (V&V) PLANNING

The Project will monitor the provider's V&V activities, to include reviews, inspections and informal technical reviews, and testing of all deliverable products. The spacecraft and instrument provider's V&V requirements are found in the SMRD, the PAR for the spacecraft [ref. 2.2-12], and the appropriate instrument PAR.

8.2.1 Approach and Activities

The provider shall present, and the Project will conduct, formal reviews at the end of each software life cycle phase. The EOS common spacecraft software reviews are listed in the SMRD. The Project may co-chair the reviews at the end of each software life cycle phase for the instrument providers. The instrument reviews are listed in the appropriate contractual documentation. The Project will have disposition authority for all RIDs emanating from any of the reviews.

After each EOS common spacecraft formal software review, the Project SSM will decide upon the readiness of the provider to begin the next development life cycle phase. The Project SAM will make a readiness recommendation to the FAM and SSM based on an assessment of status and readiness of processes, procedures and standards needed in the next phase. After completion of rework for problems found during the review, and correction of any readiness problems, permission to begin the next phase will be given. Any intermediate time between phases will be held to a minimum, in order to be cost effective. If the review was thorough, the Project may give permission to begin the next phase in parallel with the closure of action items. After each formal instrument software review, the SSM will provide a recommendation to the appropriate IM as to whether the provider is ready to begin the next development phase.

GSFC Flight Assurance reviews, found in section 2.3 of the spacecraft PAR, are in addition to the end of phase reviews specified in section 8.1.1. These Flight Assurance reviews will be at the spacecraft system level, and software will be among the items reviewed. The providers shall support these reviews as required above for Project formal reviews.

The Project will witness the formal Acceptance Testing on the software delivered to the spacecraft for Integration & Test. All discrepancies must be resolved, and all regression testing completed prior to the Project accepting the software. An Independent Verification and Validation effort by the FSSB at GSFC will use this software to conduct mission simulations involving the Flight Operations Segment. This IV&V effort will not include a requirement-by-requirement validation.

The FAM and SAM will look for the providers to conduct verification and validation activities throughout the software life cycle in accordance with their contractual requirements.

8.2.2 Methods and Techniques

The Project FAM and SAM will utilize the guidelines and processes set forth in NASA-STD-2202-93, Software Formal Inspections Standard, in carrying out all inspections of the software development process.

Requirements on the methods and techniques to be used by providers are contained in Section 8.2.2 of the SMRD.

8.2.3 Products

The results of informal reviews and walk-throughs will be documented in the appropriate Software Development Folder (see Section 5.4.7.1.9).

The provider will summarize the results of informal reviews and walk-throughs in the Monthly Progress Report.

The results of informal testing will be recorded in the appropriate software development folders.

Requirements on the DIDs to be used by providers are contained in Section 8.2.3 of the SMRD.

8.3 QUALITY ENGINEERING ASSURANCE PLANNING

N/A

8.4 SAFETY ASSURANCE PLANNING

The Project will identify safety risks (on a system level) that can be caused by the failure of software to perform as required and any system risks that are to be controlled by software during the baseline risk assessment process described in section 9.0. Identified safety risks will be tracked by the Project as technical risks.

The Project will assure that the provider conducts a software safety assurance program that satisfies the requirements of the appropriate PAR, and is documented in accordance with the applicable CDRL DID for the provider's Software Assurance Plan. Reference Section 9.3 of this document for supporting information.

8.4.1 Approach and Activities

The following activities will be performed to assure safety requirements are met:

- Safety hazards, if any, will be identified in the Project's baseline risk assessment process.
- Software requirements associated with safety hazards will be identified as critical, safety related, requirements.

8.4.2 Methods and Techniques

The Project will ensure that the provider has identified in the Software Assurance Plan the methods and techniques to be used to identify safety critical requirements and safety critical software components, and the analyses and V&V methods to be used to ensure that they function as required.

8.4.3 Products

The provider will submit risk analyses and safety hazard reports to the Project as required, and will have available for inspection by the Project the results of all safety related analyses, inspections, and tests, in the SDFs of the critical components .

8.5 SECURITY AND PRIVACY ASSURANCE PLANNING

The Project will conduct a security assessment process by considering and categorizing the sensitive information that is to be managed and controlled by the Project software. The information, including both programs and data, will be categorized according to its sensitivity. The categorization will meet the requirements contained in NMI 2410.7B [ref. 2.2-5], "Assuring the Security and Integrity of NASA Automated Information Systems."

8.5.1 Approach and Activities

The FAM and SAM will ensure that security and privacy requirements have been established for the software, data, support tools, and software development process. The Project will evaluate the providers' compliance with their requirements at the major software reviews.

8.5.2 Methods and Techniques

The FAM and SAM will assure that the providers have identified in their Software Assurance Plan or equivalent the methods and techniques to be used to comply with NMI 2410.7B.

8.5.3 Products

N/A.

8.6 CERTIFICATION PLANNING

N/A

8.7 NONCONFORMANCE REPORTING AND CORRECTIVE ACTION

The Project and each software provider shall establish a Nonconformance Reporting and Corrective Action (NRCA) system, which shall provide for the recording of nonconformances, the evaluation of impact and establishing of priority, the tracking and reporting of status, and the closure after testing. A nonconformance shall be defined as a deviation of any product from its requirements or standards. Nonconformance reports shall be filed against any product in any phase of the software life cycle after a product is first approved or baselined by its developer and released for wider use. The NRCA system shall interface with the CM system in order to track the product changes and versions that result from correcting nonconformances.

8.7.1 Approach and Activities

The FAM and SAM will assure that the NRCA requirements of the applicable instrument PAR and EOS common spacecraft PAR are being followed.

8.7.2 Methods and Techniques

A nonconformance tracking and reporting system will be used that is able to provide management reports containing error and correction status, the number of errors found per product, and the criticality of open problems. This data enables the impact of nonconformances to be evaluated so that the use of resources may be prioritized. Nonconformance reports shall be evaluated for criticality and level of importance. In addition, each nonconformance report shall be evaluated to identify those containing requirements changes disguised as nonconformances. Such reports shall be rejected.

8.7.3 Products

Each NRCA system will provide the management reports described in the previous section as well as Project access to the original paperwork or electronic file of each nonconformance submittal.

SECTION 9.0 - RISK MANAGEMENT PLAN

The objective of the Project's risk management processes is the identification and control of risks, both technical and programmatic, that could cause the acquired software to fail to satisfy its requirements, including those related to schedule and costs.

Each provider will establish an organized software risk management program that provides a systematic assessment and control of potential safety, security, technical, performance and schedule risks associated with the development and operational use of Project software. The provider's risk management program will be documented in the SMP.

The Project SSM shall review the provider's risk management program with emphasis on the following tasks:

- Identify potential risks to the Project that may arise from the planned software acquisition, development, utilization and support activities.
- Analyze the sources, if any, of each potential software related risk and forecast the possible consequences if the risk is not removed or counteracted;
- Prioritize potential risks with respect to their possible technical and programmatic impacts, the probability of those impacts occurring, and the estimated cost for precluding or abating the potential risk.
- Present to the Project the requirements for specific actions that will reduce the identified risks.

9.1 RISK ASSESSMENT AND EVALUATION PROCESS

Identification, assessment, and evaluation of risks is intended to be a continuous process. Both the Project and each provider will continuously assess software activities for risk, reporting to the Project any risks identified, along with suggested actions to reduce or eliminate the risk.

In addition, each review of the software shall address risks. At each formal review, the Project appointed reviewers will be requested to identify potential technical, safety, security, resource, schedule, or cost risks; the relative magnitude of those risks and in light of the requirements that the Project software is to satisfy, what actions should be recommended.

9.2 TECHNICAL RISKS

Following each End-of-Phase review and Project audit, the Project SSM and the Project appointed reviewers will independently assess software technical risks using products, reports and data furnished by the provider and the reports of the review panel. The results of these assessments and associated action items will be provided to the software provider, who will be required to control the risks.

The SSM will assess all waiver requests submitted by providers and advise the Project of any risks found in granting or not granting the waiver.

9.3 SAFETY RISKS

Potential software induced safety risks shall be identified through detailed safety analyses of software requirements, designs, and code. The traceability of the requirements through design and code into the test procedures shall be assured to eliminate safety risks arising from errors of omission. Elements of the software design that are identified as contributors to potential safety hazards shall be placed on a critical items list and subjected to in-depth analysis, redesign, stringent change control and extensive operational testing. See Section 8.4 for additional information.

9.4 SECURITY RISKS

The provider shall periodically review the software development environment and its control processes and procedures to ensure that the possibility of improper alteration or loss of source documentation, data or code has a low probability of occurrence. See Section 8.5 for additional information.

9.5 RESOURCE RISKS

The SSM will ensure that each provider will identify resources, and their periods of availability, that are critical to satisfying the technical and delivery requirements of the Project. These resources include, but are not limited to; technical expertise, specialized equipment and unique facilities. The provider's SMP will identify critical resources and a contingency plan that the provider will implement in the event that a resource becomes unavailable during the period during which it is critical.

9.6 SCHEDULE RISKS

The provider will maintain current schedule information that is available to the Project. In addition, the schedule shall be re-estimated as provided in section 4.3.1, and risks shall be identified during the process.

The provider's software CM process will include a process for estimation of schedule impact of proposed changes. A change to the Project master schedule can only be made by the Project CCB. See Section 10.0 of this document for more information.

9.7 COST RISKS

The provider will report current cost and cost risks as required (see Section 4.1). In addition, the cost to complete will be re-estimated as provided in section 4.1, and risks will be identified during the process.

The provider's software CM process will include a process for estimation of cost impact of proposed changes. A change to the Project's cost can only be made by the Project CCB. See Section 10.0 of this document for more information.

SECTION 10.0 - CONFIGURATION MANAGEMENT PLAN

Software CM is the discipline of identifying the configuration of software at discrete points in time and systematically controlling changes to the identified configuration for the purpose of maintaining software integrity and traceability throughout the software life cycle. This Project Software CM Plan establishes the processes the Project will use to manage the software configuration items and changes to them. This Plan is encompassed by the EOS Configuration Management Plan, [ref. 2.2-2], and the EOS Project Configuration Management Procedures Handbook, [ref. 2.2-11], hereafter referred to as the "CM Handbook". The CM Handbook satisfies the requirements of GMI 8040.1A, Configuration Management, [ref. 2.2-14].

Software CM requirements have been levied on the spacecraft software provider via section 10.4 of the Performance Assurance Requirements for EOS Common Spacecraft [ref. 2.2-12]. Instrument Software providers' requirements are found in the Performance Assurance Requirements for EOS General Instruments, [ref. 2.2-13], and other contractual documentation.

10.1 CONFIGURATION MANAGEMENT PROCESS OVERVIEW

The following sections delineate the three levels of EOS configuration management and their relationship to the two classes of changes to be managed.

10.1.1 Configuration Management Organization

The Level I Program Office for EOS CM is at NASA Headquarters and the Program Control Board (PCB) is chaired by the Program Director. The PCB dispositions major changes affecting Level I requirements from the Execution Phase Project Plan where the proposed changes will alter mission objectives, cost targets, or agency schedules.

The Project CM system is at Level II of the EOS CM Organization, covering all aspects of the EOS CHEM spacecraft and instruments, hardware and software. It will be managed and operated by the Project CMO. A description of the software duties of the CMO is given in section 4.3.3.11. Changes will be dispositioned by the Project CCB, chaired by the PM or designee. The board and membership is established by the PM. The Project SSM will attend all applicable CCB meetings.

In addition to the Level II Project CM system, there is also a Level II MTPE Management Control Board (MCB). The primary function of this MCB is to review Level I change requests approved by the Project CCB prior to their submission to the PCB. The MCB will also review and disposition controversial issues which occur between the EOS projects of different directorates. The MCB is chaired by the Director of the MTPE office.

The providers' CM System is at Level III of the EOS CM Organization. The providers shall document the details of their spacecraft and instrument CM systems and CCBs in their CM Plan as required by the EOS CM Plan, [ref. 2.2-2] and the CDRL DID requirements for their CM Plan. The providers' software CM activities shall be a subset of their total CM activities and their CM Plan shall reflect that. The Project SSM will monitor the providers' CM practices for compliance with the providers' SMP and CM Plan requirements.

10.1.2 Classification of Changes

Changes to software and associated documentation and facilities shall be classified according to the impact of the change and the approval authority needed. Class I shall be assigned to changes that will affect system requirements, GSFC software requirements, system safety, reliability, cost, schedule, and external interfaces. These changes can only be resolved by the Project. In the case of major Class I changes affecting mission objectives, the change will be elevated to the PCB in the Level I Office at NASA Headquarters. It should be noted that Class I and Level I are not synonymous. Most Class I changes are dispositioned by the Level II CCB.

Class II and lower changes shall be resolved by the provider CCB. Class II changes are those that affect the interfaces between CSCIs and the allocation of functions to CSCIs, or affect component level cost and schedule. The provider's CCB shall forward a copy of all Class II and lower changes to the Project for classification concurrence. Lower levels of changes, for example, those that affect CSCI internal design and division of functionality, may be established by the provider and resolved at lower levels.

As the launch date of the EOS CHEM spacecraft approaches, the risk in making even a small change increases. Therefore, beginning at six months before launch, ALL changes to software categorized as "Critical" (see section 5.3.2) shall be classified as Class I changes.

10.2 CONFIGURATION CONTROL ACTIVITIES

This section identifies the activities to be performed by the Project to implement the four primary CM functions of identification, change control, status accounting, and authentication.

10.2.1 Configuration Identification

Configuration identification is the process of defining each baseline to be established during the software life cycle, by describing the software configuration items and associated documentation that comprise each baseline, and by recording the names, versions, and other identifiers of each component of the baseline. Software documentation that is related to the EOS PM mission shall be baselined and put under Level III (providers) CCB control upon completion of the document as defined in the CDRL .

The software elements to be developed are described in section 3 of this document. The providers shall decompose the elements into CSCIs, CSCs, and CSUs, and the Project SSM will assure that the system of identifying these for CM purposes is unambiguous.

The provider shall develop the software baselines as required in the appropriate PAR, and make them available for Project inspection, or deliver them according to the appropriate CDRL due date.

10.2.2 Configuration Change Control

Configuration change control is the systematic process for evaluating, coordinating, and deciding on the disposition of proposed changes to the configuration items, and for implementing those changes to baselined software and associated documentation. The change control process ensures that the changes which have been initiated are classified, evaluated, approved or disapproved, documented, implemented, and verified.

10.2.2.1 CONTROLLED STORAGE AND RELEASE MANAGEMENT

The Project will utilize the MTPE Library to accept and control software baselines and other associated deliverables from providers. The MTPE Library will be linked via an electronic network to the spacecraft software provider's Management Information System (MIS). As a minimum, software documentation shall be transferred to the MTPE Library electronically. With respect to the instrument providers, copies of all deliverable software documentation shall be sent to the MTPE Library. Code and data files may also be transferred to the MTPE Library based upon contract negotiations with the providers.

10.2.2.2 CHANGE CONTROL FLOW

An orderly change process is necessary to ensure that only approved changes will be implemented into any baselined document or software. The steps within the overall process shall be as described in the following paragraphs.

10.2.2 2.1 Initiation

Class I CCRs originated by the Project will be on the EOS CCR form described in the CM Handbook. Should the Project wish to submit a Class II Change Request to the provider's CCB, the Project will use the provider's CCR form. The requirements for this form are found in the EOS Configuration Management Plan, [ref. 2.2-2] and an example shall be found in the provider's CM Plan. CCRs originated by the providers and judged to be Class I changes shall be submitted, along with an impact assessment and all required supporting documentation, to the Project CMO for processing.

10 2 2.2.2 Change Evaluation

The Project will perform an analysis of the impact of each CCR received from the provider, and each provider shall analyze all CCRs sent to it by the Project. Each change is assessed in terms of impact to system functionality and testing, to the development facilities and simulators (both hardware and software), to the ground system and operations, and to utility, risk, cost, and schedule. Each change will also be analyzed for impact on software safety, reliability, maintainability, transportability, and efficiency. Any potential change which is deemed to negatively impact another project will be submitted to that project's respective Software Manager for her/his review and assessment.

10 2.2.2.3 Change Disposition

Class I changes will be dispositioned by the Project CCB. The CCB will approve, disapprove, or defer a change request. Dispositioned items will be sent to the CMO for action and for recording of the disposition. The originator of the CCR will be notified of the disposition made by the CCB. Approved CCRs will be forwarded to the provider

Software Manager. Rejected CCRs will be sent to the originator along with the CCB rationale for rejection. Deferred CCRs will be filed, to be sent back to the Board at the proper time. The CMO, acting as the secretary of the CCB, will prepare, distribute, and file the meeting minutes, and shall maintain records of the current status of the CCR.

As stated earlier in this section Class II changes and lower will be disposed by the provider CCB. A copy of the Class II or lower changes shall be forwarded to the Project for change classification concurrence. In any dispute over the classification of a change, the PM will be the ultimate decision authority.

10.2 2.2.4 Change Implementation

Upon Project CCB approval of the CCR, the CMO will prepare a Document Change Notice (DCN) package with the assistance of the Project SM. With this package, depending on specific predetermined criteria, the TO may send a letter to the submitter of the CCR informing them of the disposition status. This letter may also include the authorization to the submitter of the CCR to implement the requested approved change. If the requester of the CCR is contractually bound with a contract and not a Memorandum of Agreement (MOA) or MOU, the CO will also send the Change Incorporation authorization at this time. The COTR will utilize a Technical Direction (TD) notice to direct the submitter of the CCR to perform the CCR task at no cost or change of performance when the CCR is determined to be within the scope of the contract.

10.2.2.2.5 Change Verification

Implemented changes shall be verified by the provider. If the implementation involves code changes, the provider shall have determined if the verification requires the rerun of tests in the test plan or the development of an addition to the test plan. Regression testing shall be included in the tests to assure that errors have not been introduced in existing functions by the change.

After the successful implementation and testing of the change described in the CCR, the CMO will record the occurrence of this process into the change request tracking data base or files.

10.2.2 3 CHANGE DOCUMENTATION

The provider shall submit change documentation as specified in the contract. Status of the CCRs will be maintained by the CMO, and reports will be issued as described in the CM Handbook, Paragraph 4.

10.2.3 Configuration Status Accounting

Configuration status accounting is the process that provides for traceability of changes to the software. It ensures that status is recorded, monitored, and reported on both pending and completed actions affecting software baselines. The process also defines the current as-built status of the code and associated documentation.

The Project CMO will be responsible for configuration status accounting record keeping and reporting activities. Records will be kept that contain the identifications of the initial software and associated documents, and their current status, status of evolving baselines, status of proposed and approved changes, and the implementation status of approved changes.

10.2.4 Configuration Authentication

Configuration authentication is the verification that a deliverable software baseline contains all of the items which are required, and that these items have themselves been verified, i.e., they satisfy their requirements. An audit or inspection shall be conducted by the provider before each delivery of code products to the Project. The Project shall be notified prior to all such audits and inspections, and provision shall be made for Project participation in the audit and/or inspection.

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SECTION 11.0 - DELIVERY AND OPERATIONAL TRANSITION

The Project will assure a successful delivery of contractual software products from the software providers to the contractors or government users. The SSM and IMs will evaluate the providers' Delivery and Operational Transition Plans and SMPs for completeness and accuracy. If the Plans highlight discrepancies between the two parties delivering and receiving a product, the Project will work with both parties to resolve the discrepancies.

11.1 SITE PREPARATION PLANNING

This section covers the planning required to facilitate the software and related hardware deliveries, and their operation by the end users.

11.1.1 Facility Planning

Under the guidance of the Project, the spacecraft contractor shall plan with each instrument contractor for the delivery of the instrument and associated GSE and software to the spacecraft I&T facility. The instrument software providers shall deliver code and data in Random Access Memory (RAM) or Read-only Memory (ROM), a validated OASIS-formatted database, and validated CSTOL procedures to the spacecraft contractor I&T Team. The specific requirements for the computer equipment floor space, power and cabling, temperature control, maintenance, etc. to support the instrument GSE during I&T shall be documented in the I&T ICD between each instrument contractor and the spacecraft contractor.

Under the guidance of the Project, the spacecraft contractor shall plan with the GSFC FSSB for the delivery of the IV&V Facility hardware and software to GSFC. The specific requirements for the computer equipment floor space, power and cabling, temperature control, hardware and software maintenance responsibilities, software change control process, etc. shall be documented in the spacecraft contractor's Delivery & Operational Transition Plan, and in the MOU between the Project and the FSSB.

Under the guidance of the Project, the spacecraft contractor shall plan with the ESDIS Project for the delivery of the EOC Training Simulator hardware and software to GSFC. The specific requirements for the computer equipment floor space, power and cabling, temperature control, hardware maintenance, EOS Training Simulator (e.g. Spacecraft Simulator) software maintenance responsibilities, software change control process, etc. shall be documented in the spacecraft contractor's Delivery & Operational Transition Plan, and the Interface Requirements Document between ECS and NASA Code 424/CHEM Spacecraft Simulator.

11.1.2 Transition Planning

The following transitions must be successfully accomplished. In cooperation with appropriate operations personnel, the SSM will assure that planning for these transitions is reflected in the entire software life cycle development process, and especially in CDRL items such as the Requirements Document and User's Guide. MOUs and ICDs with other GSFC organizations will also include transition planning.

(a) Prior to launch, except for several end-to-end tests, all spacecraft flight software operations shall be the responsibility of the spacecraft contractor I&T team. Spacecraft CSTOL test procedures, OASIS-formatted spacecraft databases, spacecraft flight software, and command loads for the spacecraft flight software shall be under configuration management during I&T to ensure that any changes are captured and recorded. At the conclusion of the I&T phase, some of this material will transition to the spacecraft contractor's flight operations team for use in launch-site and on-orbit checkout operations. Configuration management shall be continued throughout the on-orbit checkout phase to ensure that all operations-related data and procedures will be handed over to the permanent flight operations team, and to the NASA flight software maintenance team, in a known condition.

(b) Instrument CSTOL test procedures, OASIS-formatted instrument databases, and command loads for the instrument flight software shall be transferred to the spacecraft contractor's I&T team during integration of the instrument with the spacecraft. Prior to launch, except for several end-to-end tests, all instrument flight software operations shall be the responsibility of the spacecraft contractor I&T team. However, regardless of which ground system sends the commands, the instrument's Principal Investigator and Science Team shall always be responsible for the content of the commands and the performance of the instrument flight software. Prior to integration with the spacecraft, the instrument CSTOL test procedures, OASIS databases and instrument commands shall have been validated by the instrument contractor on the IGSE.

Instrument CSTOL test procedures, OASIS-formatted instrument databases, instrument flight software, and command loads for the instrument flight software shall be under configuration management during I&T to ensure that any changes are captured and recorded. At the conclusion of the I&T phase, some of this material will be used in instrument operations.

(d) After a TBD period after on-orbit checkout of the spacecraft is completed, responsibility for spacecraft flight software maintenance will transition to the FSSB maintenance team. Chairmanship of the CCB which approves flight software changes will transition to the ESDIS project in the same time frame.

(d) The spacecraft contractor will develop, test and validate flight software using a collection of hardware and software tools known as the SDV (see Section 3.1.3). This system (or a replication of it) will be delivered to GSFC be used by the FSSB IV&V team. After flight software maintenance responsibility transitions to FSSB, this system will be used to develop, test and validate flight software updates. After delivery and acceptance, the FSSB maintenance team will be responsible for operation and maintenance of both the hardware and software components of this system.

(e) Portions of the SDV hardware and software will also be delivered to GSFC in the form of the EOC Training Simulator for use by the FOT.

11.2 DELIVERY PLANNING

Table 11.2-1 provides a pictorial representation of some of the delivery interdependencies between GSFC, the instrument provider, the spacecraft contractor, the Science Data Processing Segment (SDPS), the Flight Operations Segment (FOS), and the Flight Software Systems Branch (FSSB). The instruments' and spacecraft's contract and CDRLs define the specific items to be delivered, their due dates, and responsible agency action. The format of the deliveries will be mutually agreed upon by the parties involved if a specific contractual requirement does not exist. Note that the table shows only the eventual end-user of each item, regardless of any intermediate organizations which may be involved in the transfer.

11.3 DATA CONVERSION PLANNING

The project requirement to use the OASIS database format and CSTOL procedure language following established guidelines is intended to minimize or eliminate a need for data conversion during the instrument and spacecraft integration process. If the FOS does not use OASIS in the EOC, it will be the responsibility of the FOS to perform any necessary data conversion on the spacecraft database and procedures.

11.4 USER TRAINING PLANNING

In coordination with appropriate operations personnel, the SSM will verify that future training plans are specified in the instrument and spacecraft SMPs. Training shall provide for the transitions referenced in section 11.1.2:

(a) Prepare the FOT to operate the CHEM spacecraft and instrument flight software and hardware during normal and anomalous events.

Prepare the FSSB IV&V Team to operate the IV&V Facility hardware and software during normal and anomalous events, including the creation of new flight software loads for the spacecraft. Refer to Section 5.4.5 for supporting information.

(b) Prepare the spacecraft contractor I&T Team to test the CHEM instrument flight software during normal and anomalous events.

(c), (d) Prepare the FSSB Software Maintenance Team to take over the responsibility of all new spacecraft flight software and SDV software modifications after the end of the early-orbit checkout phase. Refer to Section 7 for supporting information.

(e) Prepare the FOT to operate the EOC Training Simulator hardware and software during normal and anomalous events. Refer to Section 5.4.5 for supporting information.

TO FROM	TO CSFP PROJECT	TO SCIENCE TEAM	TO S/C PROVIDER	TO INSTRUMENT PROVIDER	TO SDPS	TO FOS	TO FSSB
FROM CSFP PROJECT	n/a	SOW WBS CDRL	SOW SPEC GIRD WBS SMRD CDRL OASIS DATABASE GUIDELINES	SOW SPEC GIRD WBS ISMRD CDRL OASIS DATABASE GUIDELINES		FOS CDRL ITEMS	
FROM SCIENCE TEAM		n/a			CDRL ITEMS		
FROM S/C PROVIDER	CDRL ITEMS		n/a	INSTRUMENT CDRL ITEMS		TRAINING SIMULATOR S/W PROJECT DATABASE FLIGHT SOFTWARE CSTOL PROCEDURES TRAINING	SDV S/W OASIS DATA BASE FLIGHT SOFTWARE
FROM INSTRUMENT PROVIDER			INSTRUMENT FLIGHT S/W OASIS DATABASE CSTOL TEST PROCEDURES INSTRUMENT COMMAND LOADS	n/a	SCIENCE S/W		
FROM SDPS				ALGORITHM DEVEL TOOLS	n/a		
FROM FOS						n/a	SOFTWARE PROBLEM REPORTS
FROM FSSB						FLIGHT SOFTWARE UPDATES	n/a

Table 11 2-1 EOS Common Spacecraft Delivery Dependencies

SECTION 12.0 - ABBREVIATIONS AND ACRONYMS

ACRIM	Active Cavity Radiometer Irradiance Monitor
AMR	Altimetry Microwave Radiometer
CASE	Computer Aided Software Engineering
CCB	Configuration Control Board
CDR	Critical Design Review
CDRL	Contract Deliverable Requirements List
CERES	Clouds and Earth's Radiant Energy System
CII	Chemistry International Instrument
CM	Configuration Management
CMO	Configuration Management Officer
CNES	Centre National d'Etudes Spatiales
CO	Contracting Officer
COTR	Contracting Officer's Technical Representative
COTS	Commercial Off-The-Shelf
CPU	Central Processing Unit
CR	Change Request
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
CSF	Chemistry & Special Flights
CSFP	Chemistry & Special Flights Project
CSTOL	Colorado Standard Test and Operations Language
CSU	Computer Software Unit
DAAC	Distributed Active Archive Center
DFA	Dual Frequency Altimeter
DID	Data Item Description
DORIS	Doppler Orbitography & Radiopositioning Integrated by Satellite
EBNET	EOSDIS Backbone Network
ECS	EOSDIS Core System
EDOS	EOS Data & Operations System
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
ESDIS	Earth Science Data and Information System (Project)
FCA	Functional Configuration Audit
FDD	Flight Dynamics Division
FOS	Flight Operations Segment (of the ECS)
FOT	Flight Operations Team
FSSB	(GSFC) Flight Software Systems Branch
GFS	Government Furnished Software
GLAS	Geoscience Laser Altimeter System
GMI	GSFC Management Instruction
GSE	Ground Support Equipment

GSFC	Goddard Space Flight Center
HIRDLS	High Resolution Dynamics Limb Sounder
HOL	High Order Language
I&T	Integration & Test
ICC	Instrument Control Center
I/O	Input/Output
ICD	Interface Control Document
IGSE	Instrument Ground Support Equipment
IRD	Interface Requirements Document
IST	Instrument Support Terminal
ISTG	Independent Software Test Group
IT	Instrument Team
IV&V	Independent Verification & Validation
JPL	Jet Propulsion Laboratory
LASP	Laboratory for Atmospheric and Space Physics
LIS	Lightning Imaging Sensor
MLS	Microwave Limb Sounder
MR	Microwave Altimeter
MOU	Memorandum of Understanding
MTPE	Mission To Planet Earth
NCAR	National Center for Atmospheric Research (Boulder, Colorado)
NPV	Numerical Progress Value
NRCA	Nonconformance Reporting and Corrective Action
OASIS	Operations and Science Instrument Support
ODUS	Ozone Dynamic Ultraviolet Explorer
OM	Operations Manager
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PI	Principal Investigator
PM	Project Manager
PMS	Performance Measurement System
PODS	Precision Orbit Determination System
RAL	Rutherford Appleton Laboratory
RAM	Random Access Memory
ROM	Read-Only Memory
SAGE III	Stratospheric Aerosol & Gas Experiment
SAM	Software Assurance Manager
SCF	Science Computing Facility
SCM	Software Configuration Management
SDF	Software Development Folder
SDL	Software Development Library
SDPS	Science Data Processing Segment (of the ECS)

SDV	Software Development & Validation (System)
SSM	Software Systems Manager
SMP	Software Management Plan
SMR	Software Management Review
SMRD	Software Management Requirements Document
SOLSTICE	Solar Stellar Irradiance Comparison Experiment
SOW	Statement of Work
SPAR	Standard Payload Assurance Requirements
SQA	Software Quality Assurance
SQE	Software Quality Engineering
SRMB	Software Risk Management Board
SRR	Software Requirements Review
SSALT	Solid State Altimeter
SSE	Software Support Environment
SSR	Software Specifications Review
STOL	Standard Test and Operations Language
SWAR	Software Acceptance Review
TBD	To Be Determined
TES	Tropospheric Emission Spectrometer
TL	Team Leader
TOMS	Total Ozone Mapping System
TRMM	Tropical Rainfall Measuring Mission
TRR	Test Readiness Review
V&V	Verification and Validation
WBS	Work Breakdown Structure

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SECTION 13.0 - GLOSSARY

For terms not appearing in this glossary, refer to the IEEE Standard Glossary (as referenced in Section 2.1).

Acceptance Review (AR) The phase transition review for the Acceptance and Delivery life cycle phase.

Acquirer An organization that obtains a capability, such as a software system.

Adaptation The tailoring of the documentation standards (within the specifications of the rules and guidelines) for a specific program project, or software system.

Assurance Those activities, independent of the organization conducting the activity, that demonstrate the conformance of a product or process to a specified criteria (such as a design or a standard).

Assurance and Test Procedures One of four logical volumes in a documentation set; it encompasses all the technical (i.e., nonplanning) aspects of the assurance activities.

Baselining The official acceptance of a product or its placement under configuration management as defined in the Management Plan.

Certification The process of confirming that a system, software subsystem, or computer program is capable of satisfying its specified requirements in an operational environment. Certification usually takes place in the field under actual conditions, and is used to evaluate not only the software itself, but also the specifications to which the software was constructed. Certification extends the process of verification and validation to an actual or simulated operational environment.

Computer Software Component (CSC) A functional or logically distinct part of a computer software configuration item. Computer software components may be top-level or lower level

Computer Software Configuration Item (CSCI) A collection of software elements treated as a unit for the purpose of configuration management.

Computer Software Unit (CSU) The smallest logical entity specified in the design of a computer software component and the actual physical entity in code that implements a testable aspect of the requirements. This is the smallest unit for which documentation may be required.

Critical Design Review (CDR) The phase transition review for the Detailed Design life cycle phase.

Data Item Description (DID) The table of contents and associated content description of a document or volume.

Developer The provider organization responsible for development of software.

Document A physically separate book in a documentation set.

Documentation Set The four logical volumes for a software system. These volumes are the Management Plan; Product Specification; Assurance and Test Procedures; and Management, Engineering, and Assurance Reports.

Evolutionary Acquisition The acquisition of software over a relatively long period of time in which two or more complete iterations of a life cycle will be employed to revise and extend the system to such an extent as to require a major requirements analysis and therefore subsequent life cycle iterations.

Firmware Hardware that contains a computer program and data that cannot be changed in its user environment. The computer programs and data contained in the firmware are classified as software; the circuitry containing the computer program and data is classified as hardware.

Functional Configuration Audit (FCA) The formal examination of functional characteristics' test data for a computer software configuration item, prior to acceptance, to verify that the item has achieved the performance specified in its functional or allocated configuration identification.

Hardware Physical equipment used in data processing, as opposed to computer programs, procedures, rules, and associated documentation.

Increment A predefined set of units integrated for integration testing by the development organization in response to incremental development plans.

Incremental Development The process of developing a product before delivery in a series of segments. These segments remain internal to the development organization. The process is used to help minimize risk. The segments are defined based on the design and documented in the Design section of the Product Specification. The process leads to a single delivery unless used in conjunction with "phased delivery."

Independent Verification and Validation (IV&V) Verification and validation performed by an organization independent of the development organization. For complete independence, the IV&V organization reports directly to and is funded directly by the acquirer.

Life Cycle (software) The period of time that starts when a software product is conceived and ends when the software is no longer available for use. The software life cycle traditionally has eight phases: Concept and Initiation; Requirements; Architectural Design; Detailed Design; Implementation/Coordination; Integration and Test; Acceptance and Delivery; and Sustaining Engineering and Operations. This example is referred to as the waterfall life cycle.

Management, Engineering, and Assurance Reports One of four logical volumes in the documentation set; it represents a "logical" home for all reports and request forms.

Management Plan One of four logical volumes in a documentation set; it encompasses all planning information, including management, engineering, and assurance planning.

Metric Quantitative measure of extent or degree to which software possesses and exhibits a certain characteristic, quality, property, or attribute.

Partitioning The process of determining the content for each delivery when using the phased delivery approach, or for determining the content of each segment when using incremental development.

Phase The period of time during the life of a project in which a related set of software engineering activities are performed. Phases may overlap.

Phase Transition Review The review at the end of a phase triggering transition to the next phase.

Phased Delivery The process of developing and delivering a product in stages, each providing an increasing capability for the software. The process may be employed to provide an early operational capability to users, for budgetary reasons, or because of risk, size, or complexity. Each delivery should undergo acceptance testing prior to release for operational use. The capabilities provided in each delivery are determined by prioritizing and partitioning the requirements. This is to be documented in the Requirements section of the Product Specification.

Physical Configuration Audit (PCA) The formal examination of the "as-built" configuration of a unit of a computer software configuration item against its technical documentation in order to establish the computer software configuration item's initial product configuration identification.

Preliminary Design Review (PDR) The phase transition review for the Architectural Design life cycle phase.

Product Specification One of four logical volumes in a documentation set; it encompasses all the technical engineering information related to the development of the software.

Prototyping A process used to explore alternatives and minimize risks. Prototyping can be used in any life cycle phase. The product of the process is usually a report.

Provider An organization providing a capability to an acquirer; e.g., the developer or an organization providing IV&V.

Quality Assurance (QA) A subset of the total assurance activities generally focused on conformance to standards and plans.

Quality Engineering The process of incorporating reliability, maintainability, and other quality factors into software products.

Repository A collection of standards, procedures, guides, practices, rules, etc., that supplements information contained in a documentation set. In general, the documentation set describes " what" is to be done and the repository provides the "how to" instructions. A repository usually contains information that is applicable to multiple software systems.

Requirements Allocation The process of distributing requirements of a software system to subordinate software subsystems or lower level elements.

Requirements Partitioning The process of distributing requirements of software to different deliveries in support of phased delivery.

Requirements Review (RR) The phase transition review for the Requirements life cycle phase.

Review Item Discrepancy A type of discrepancy report used when reviewing documentation

Risk The combined effect of the likelihood of an unfavorable occurrence and the potential impact of that occurrence.

Risk Management The process of assessing potential risks and reducing those risks within budget, schedule, and other constraints.

Roll-out A mechanism for recording sections of a volume in physically separate documents while maintaining traceability and links to the parent document.

Software Programs, procedures, rules, and any associated documentation and data pertaining to the operation of a computer system. including programs and data contained in firmware.

Template DID Framework used in the roll-out process for defining the specific format of a section rolled-out into a physically separate document.

Test Readiness Review (TRR) The phase transition review for the Integration and Test life cycle phase.

Testing The process of exercising or evaluating software by manual or automated means to demonstrate that it satisfies specified requirements or to identify differences between expected and actual results.

Tool A hardware device or computer program used to help develop, test, analyze, or maintain another device or computer program or its documentation.

Unit Computer Software Unit.

Verification and Validation 1) The process of evaluating software to ensure compliance with requirements and determining whether or not the products of a given phase of development fulfill the requirements established during the previous phase. 2) The process of ensuring that software being developed or maintained satisfies functional and other requirements and that each step of the development process yields the right products.

Volume	One of the four basic types of information to be addressed for each software acquisition/development activity. The four volumes are the Management Plan; Product Specification; Assurance and Test Procedures; and Management, Engineering, and Assurance Reports.

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